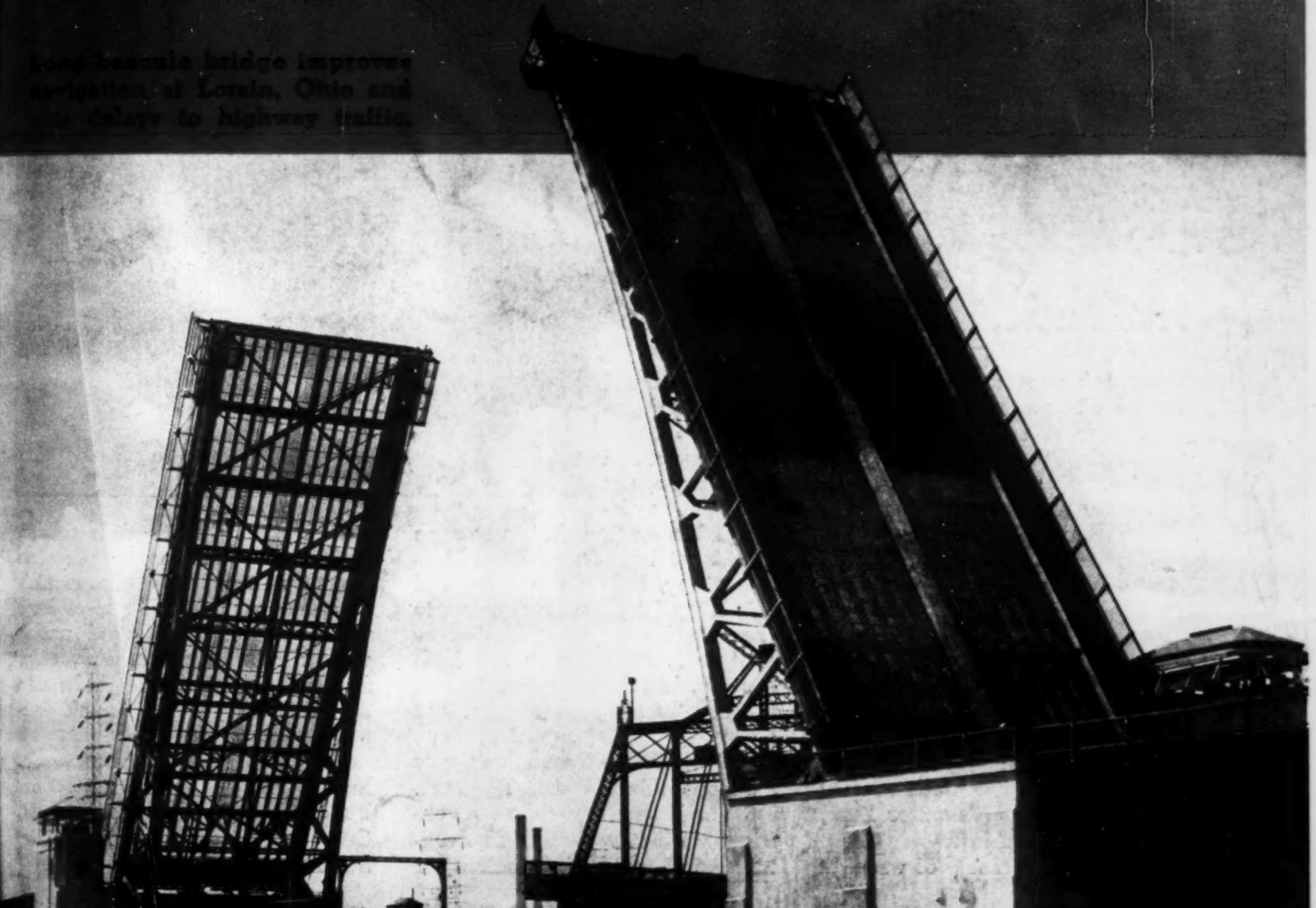
ENGINEERING NEWS-RECORD

DEC 9 1940

DECEMBER 5
1940

Air Conditioning Affects Structural Design

Improved Landfill Practice Saves Money



Long bascule bridge improves navigation at Lorain, Ohio and cuts delays to highway traffic.

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BYERS WROUGHT IRON

for "Corrosion Insurance" ON THIS 48" PENSTOCK

Penstock service is generally severe, but one recently installed at Bucksport, Maine, for a large power plant faced particularly difficult conditions. It serves as an intake for condenser cooling, handling salt and brackish river water. The pipe extends out into the stream, and so the exterior is exposed to corrosive attack from both water and soil. Repairs naturally would be difficult and costly. The engineers specified wrought iron for the job. The finished penstock, 239' long and 48" in diameter, is built of Byers Wrought Iron 3/8" plates. Wrought iron was also used extensively for fresh water lines, and condensate lines.

The superior ability of wrought iron to withstand salt water corrosion has been demonstrated many times, not only in submerged water lines but in sewage outfalls, oil lines for off-shore loading, piling, bridge members, and ship hulls. An excellent example of penstock service is provided by a 5' line, installed in the 19th century. At last reports, it had been on the job for 52 years. Not one cent was spent for maintenance during the first 40 years, and only $.50 annually the next 12 years.

If you have any problem in connection with the design or maintenance of penstocks, conduits, or similar piping exposed to severe corrosion, our Engineering Service Department will be glad to furnish authentic service records of how wrought iron has served under similar circumstances. Ask, also, for our bulletin, "Wrought Iron in Salt Water Services," which contains some helpful information.

A. M. Byers Co., Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

Corrosion costs you more than Wrought Iron

BYERS GENUINE WROUGHT IRON

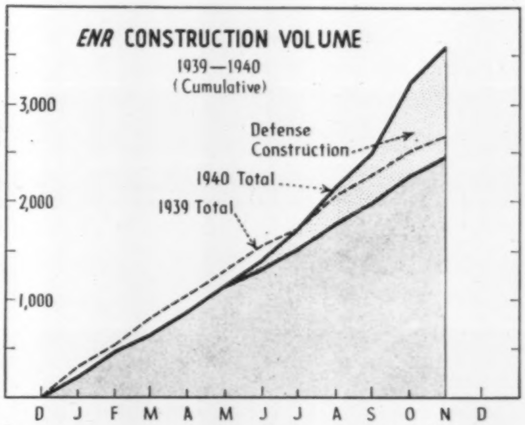
TUBULAR AND FLAT ROLLED PRODUCTS

STEEL TUBULAR PRODUCTS

CONSTRUCTION TRENDS

Notes on significant movements in the construction industry

Defense Construction Analysis



IN THE SIX MONTHS since June almost one-third of the $3,588,539,000 *ENR* 1940 construction volume has been spent on defense projects or on expansion in industries or facilities closely allied to defense.

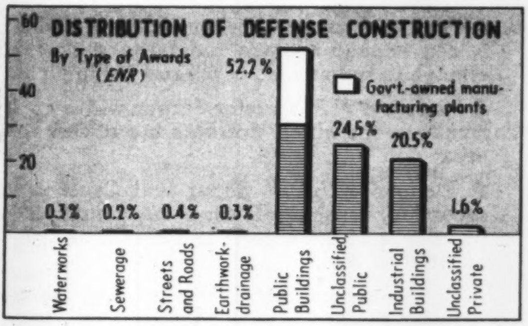
Data extracted from *ENR* Construction Reports reveal $1,143,000,000 in defense work let in the period from June through November. Federally financed projects make up the bulk of these awards, 74 per cent; private funds are responsible for 22 per cent; and the WPA participates to the extent of 4 per cent. Yet in spite of this huge addition to construction work, civil non-defense construction is holding its pace.

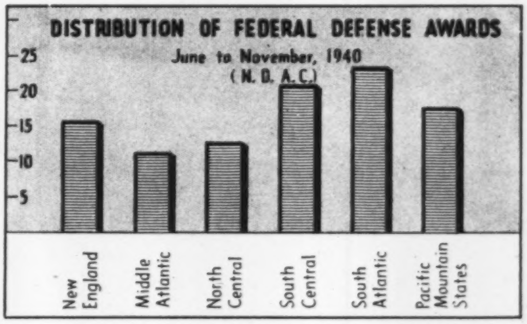
Public expenditures for defense, $891,000,000 are divided as follows: waterworks, $3,253,000; sewerage, $1,787,000; highways and bridges, $4,927,000; earthwork and drainage, $3,252,000; airports, airbases, naval bases, docks, shipways, etc., $279,819,000; and public buildings, $598,221,000. This last figure is for barracks, cantonments, defense housing for civilian and military personnel, and in addition includes $259,317,000 for government-owned manufacturing plants.

The private awards for defense work, $252,000,000, are made up of $234,000,000 in industrial plant expansion and construction in aircraft, machine and machined parts, oil refining, steel, engine plants and other strategic war industries; and $18,000,000 in shipyards, communication and transportation facilities, and miscellaneous other work.

A summary of all defense contracts awarded in United States and its possessions by the War and Navy Departments reveals $7,616,000,000 in awards of all types have been made in the five months from June through October. The report, released by the National Defense Advisory Commission, states that 42.5 per cent of the total is for ship construction; 19.8 per cent is for airplanes, engines, etc.; 16.3 per cent, ordnance and ammunition; 11.0 per cent for engineering construction; and 10.4 per cent for all manufacturing not included in the other classifications.

The engineering construction contracts noted above amount to $839,590,000, with $78,649,000 for projects in the possessions, $30,479,000 not yet assigned, and $730,462,000 for continental United States.





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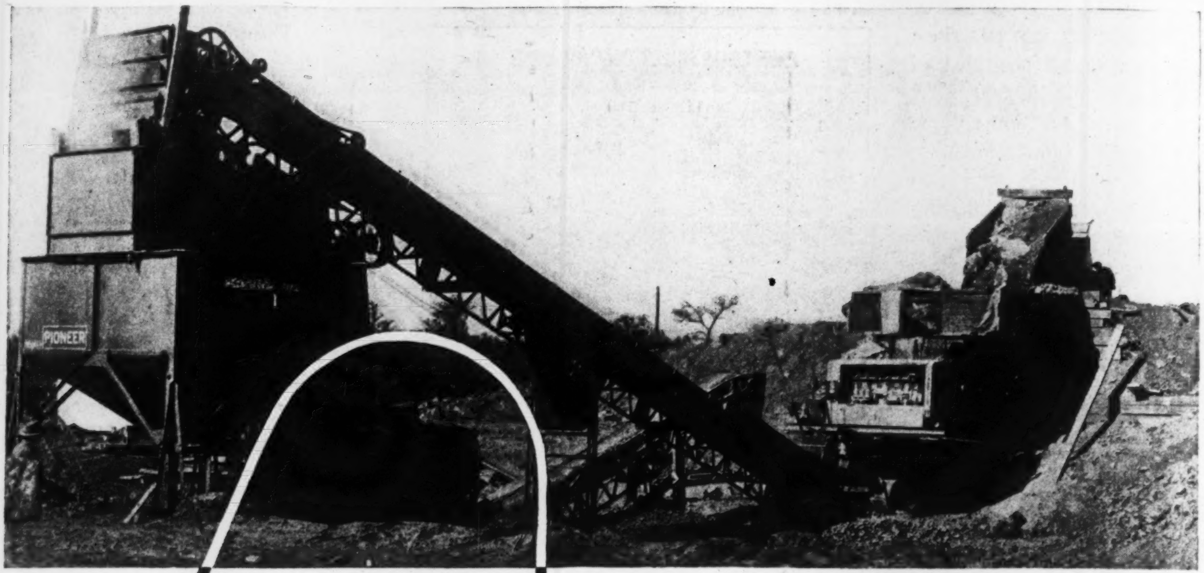
PIONEER Foto Facts

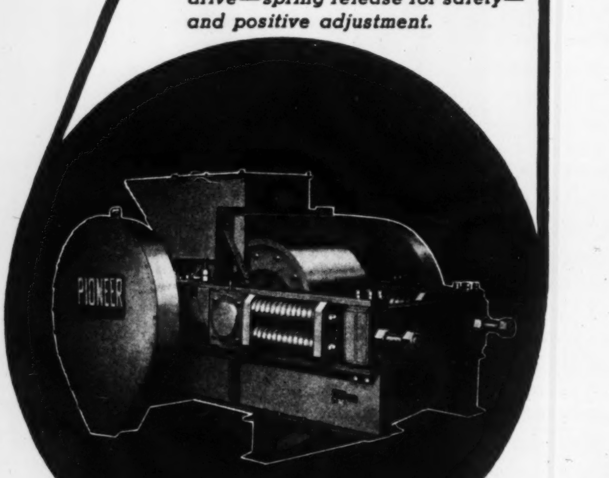
NUMBER TEN

✱ PROFITS ARE MADE IN THE *EXTRA TONNAGE* PRODUCED—



ONE OF THE SECRETS OF *Extra Tonnage* IS THE SECONDARY ROLL CRUSHER.....

The Pioneer 40x22 Roll Crusher is extra heavy for the tough jobs. It has manganese steel shells 40" in diameter and 22" face—all gear drive—spring release for safety—and positive adjustment.



Producers have found that the big profits are made in the extra tonnage that they produce. By changing certain units in this plant, the owner was able to double his output. The overhead remained the same and the result was greater earnings.

Here's how he did it:

A Pioneer Traveling Grizzly Feeder that handles the Feed economically and efficiently.

A Pioneer Primary Crusher — size 24"x36", that is big enough to take the large rocks and fast enough to keep ahead of the rest of the plant.

A Pioneer 4'x12' Vibrator Screen with a ***split feed*** arrangement which ***doubles*** the effective screen area.

A Pioneer 40"x22" Super Roll Crusher for the secondary crushing. It takes the oversize from the two decks of the screen and crushes to the finished product size.

A Belt Conveyor System that conveys the material between the crushers and screen.

By adding the Traveling Grizzly Feeder and these larger Crushers, he stepped his production up from 800 to 1600 cubic yards of rock per day. The big profits are made in the extra 800 cubic yards.

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MINNEAPOLIS • MINNESOTA

ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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F. E. SCHMITT *and* WALDO G. BOWMAN, *Editors* • ALBERT E. PAXTON, *Manager*

Vol. 125 DECEMBER 5, 1940 No. 23

THIS WEEK

• The recent collapse of the Tacoma Narrows suspension bridge has focused attention on the desirability of further investigation and studies in the whole field of aerodynamics in relation to bridge design. What has been done and the devices used in safeguarding other similar bridges are pertinent to any study of this subject. In this issue stabilizing methods as applied to the well known Whitestone, Thousand Island and Deer Isle structures are presented.

• Every soil testing laboratory technician has dreamed of the day when a perfect or non-distorted specimen would be found. While that day may be a long way off yet, there is reason for renewed hope. The Missouri River Division, U. S. Engineer Department, has been working on the problem for two years looking toward the development of adequate mechanical equipment for proper soil sampling. Its latest developments are described in this issue.

• How New York City is disposing of a third of its mixed refuse at an annual saving of $2,000,000 through the development of an improved landfill practice will be of interest to sanitary engineers, realtors, and municipal executives in every section of the country. In this issue is a detailed account of this development.

THINGS TO COME

• The Hoover Library at Stanford University is a 279-ft.-high tower, 52½ ft. square on a 122-ft. square base. The commission called for an earthquake-resistant structure. How the engineers and architects designed the structural steel frame to carry wind loads and reinforced concrete outer walls to carry earthquake loads is an interesting story that will be published in the Dec. 19 issue.

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Number of copies of this issue printed: 34,720

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Our special Contractors and Builders Division will be glad to work with you on your next job. Whether your problem is one of intricacy of design, large or small tonnage, special service, or limited time, a Ryerson engineer can probably save you time and money. On your next job get in touch with the plant nearest you. Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Cleveland, Boston, Buffalo, Philadelphia, Detroit, Jersey City.

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MONTHLY CONSTRUCTION BUSINESS SUMMARY

ENR CONSTRUCTION VOLUME AND NEW CAPITAL . . . FHA MORTGAGES

(,000 omitted)	November 1939 (5 wk.)	November 1940 (4 wk.)	% Change †	Eleven Months 1939 (48 wk.)	Eleven Months 1940 (48 wk.)	% Change
Total Construction	$302,215	$382,724	+58.0	$2,812,529	$3,588,539	+28.0
Private Construction	111,632	101,590	+14.0	829,165	1,062,568	+28.0
Public Construction	190,583	281,134	+84.5	1,983,364	2,525,971	+27.0
Federal	34,857	184,396	+561.0	331,541	1,233,289	+272.0
Total New Productive Capital	$119,491	$77,617	−19.0	$2,352,917	$3,610,990	+53.0
Private Investment	116,042	39,146	−58.0	735,748	690,421	−6.0
Federal (non-federal work)	3,449	38,471	+1,293.0	489,141	638,608	+31.0
Federal (federal work)	....	....	....	1,128,028	2,281,961	+102.0
FHA Mortgages Selected for Appraisal	$80,699	$81,949*	+1.5	$1,056,691	$1,192,504*	+13.0

† *Adjusted for difference in number of weeks.* * *Preliminary.*

CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

	December 1939	December 1940	% Change	Change November to December 1939 Nov.	1939 Dec.	%	1940 Nov.	1940 Dec.	%
E N R Construction Cost Index, 1913 = 100	238.17	249.12	+4.2	238.20	238.17	‡	247.24	249.12	+0.8
E N R Building Cost Index, 1913 = 100	201.21	208.19	+3.5	201.24	201.21	‡	206.24	208.19	+0.9

ENR 20-CITIES' AVERAGE

	December 1939	December 1940	% Change	1939 Nov.	1939 Dec.	%	1940 Nov.	1940 Dec.	%
Common Labor	$0.685	$0.711	+3.8	$0.685	$0.685	0	$0.711	$0.711	0
Skilled Labor (Av. 3 trades)	1.463	1.481	+1.2	1.463	1.463	0	1.480	1.481	+0.1
Bricklayers	1.563	1.568	+0.3	1.563	1.563	0	1.568	1.568	0
Structural Ironworkers	1.519	1.542	+1.5	1.519	1.519	0	1.542	1.542	0
Carpenters	1.306	1.332	+2.0	1.306	1.306	0	1.330	1.332	+0.2
Cement, per bbl	$2.60	$2.53	−2.7	$2.60	$2.60	0	$2.54	$2.53	−0.4
Reinforcing steel, cwt	2.57	2.53	−1.6	2.56	2.57	−0.4	2.53	2.53	0
Struct. steel, base price	2.10	2.10	0	2.10	2.10	0	2.10	2.10	0
Sand, per ton	1.20	1.17	−2.5	1.20	1.20	0	1.17	1.17	0
Lumber, 2x4 Fir, per M ft.	35.09	39.80	+13.4	35.09	35.09	0	37.76	39.80	+5.4
Lumber, 2x4 Pine, per M ft.	31.71	37.57	+18.5	31.77	31.71	−0.2	36.15	37.57	+3.9
Brick, common, per M	14.39	14.44	+0.3	14.39	14.39	0	14.44	14.44	0
Ready-mixed concrete, c.y.	7.11	6.96	−2.1	7.10	7.11	+0.1	6.94	6.96	+0.3
Struct. clay tile, 3x12x12	73.68	74.79	+1.5	73.68	73.68	0	74.79	74.79	0
Paving asphalt, cars, ton	13.95	14.21	+1.9	13.77	13.95	+1.3	14.21	14.21	0

‡ *Less than .05 per cent change.*

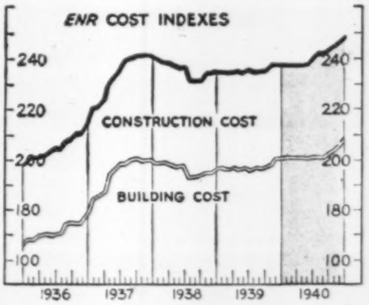
MATERIAL SHIPMENTS . . . BUILDING PERMITS

	November 1939	November 1940	% Change	Oct. 1940	% Change Oct.-Nov.
Lumber (% 1929 wk. seas. av.) N. L. M. A.	78.0	88.0	+13.0	85.5	+3.1
Steel (% operating capacity) A. I. S. I.	93.6	96.3	+3.0	94.8	+1.7

	October 1939	October 1940	% Change	Ten Months 1939	Ten Months 1940	% Change
Fabricated Structural Steel, tons, A. I. S. C.	133,849	139,221	+4.1	1,195,657	1,199,045	+0.3
Cement, thous. bbl., U. S. B. of M.	12,829	15,824	+23.3	105,323	111,799	+6.2
Building Permits, Dun & Bradstreet, (,000 omitted)	$117,914	$137,170	+16.3	1,063,071	1,146,586	+7.9

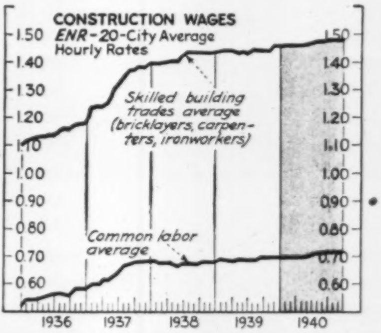
RENT INDEX . . . EMPLOYMENT

	October 1939	October 1940	% Change	Sept. 1940	% Change Sept.-Oct.
Rent (Housing) Index, N. I. C. B.	86.6	87.4	+0.9	87.0	+0.5
Est. Total Employment, thous., N. I. C. B.	46,626	48,638	+4.0	48,535	+0.2
Est. Construction Employment, thous., N.I.C.B.	2,183	2,738	+25.0	2,648	+3.2



ENR INDEX NUMBERS

Base = 100	Construction Cost 1913	Construction Cost 1926	Building Cost '13	Building Cost '26	Volume '13	Volume '26
Dec., 1940	249.12	119.75	208.19	112.54	...	...
Nov., 1940	247.24	118.85	206.24	111.49	331	145
Oct., 1940	245.02	117.78	204.02	110.29	490	215
Sept., 1940	244.13	117.35	203.13	109.83	324	142
Aug., 1940	242.18	116.42	201.71	109.04	281	123
July, 1940	242.15	116.40	201.68	109.02	308	135
June, 1940	241.59	116.13	201.65	109.00	225	99
May, 1940	238.86	114.82	201.17	108.75	201	88
Apr., 1940	238.26	114.53	201.44	108.89	191	84
Mar., 1940	238.29	114.55	201.47	108.91	162	71
Feb., 1940	238.32	114.56	201.50	108.93	196	86
Jan., 1940	238.34	114.57	201.52	108.94	173	76
Dec., 1939	238.17	114.49	201.21	108.77	172	75
Nov., 1939	238.20	114.50	201.24	108.78	219	96
1940 (Av.)	241.96	116.31	202.81	109.64	...	...
1939 (Av.)	235.51	113.21	197.44	106.73	211	92
1938 (Av.)	235.86	113.34	196.83	106.40	197	86
1937 (Av.)	234.71	112.66	196.15	106.07	172	75



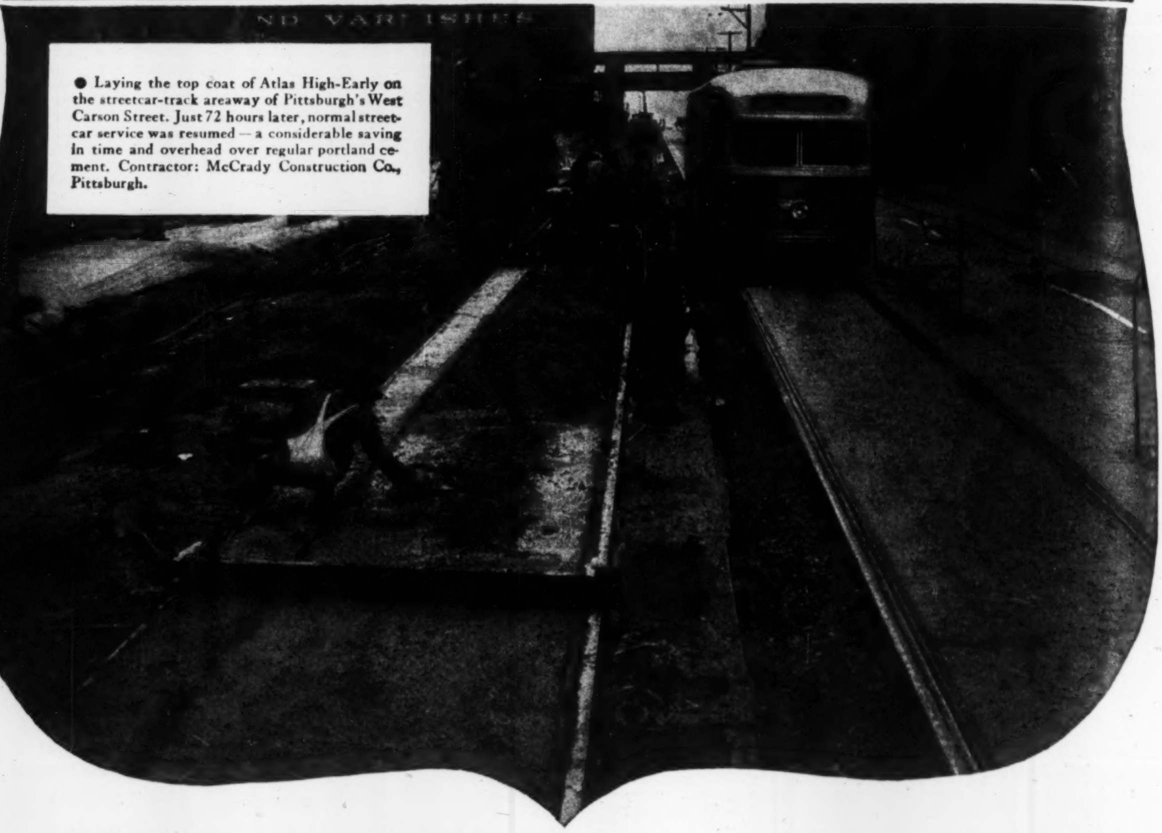
ENGINEERING CONSTRUCTION CONTRACTS——ENGINEERING NEWS-RECORD——NOVEMBER, 1940

Engineering News-Record *reports projects of the following minimum costs;— water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000

Four Weeks — Thousands of Dollars (000 Omitted)

Public Works	**New England**	**Middle Atlantic**	**South**	**Mid West**	**West of Mississippi**	**Far West**	**United States November 1940**	**United States Eleven Months 1940**	**United States Eleven Months 1939**	**Canada**
Waterworks	86	1,434	974	431	500	382	**3,807**	**66,745**	157,914	538
Sewerage	55	2,737	493	1,246	1,339	960	**6,830**	**84,651**	152,065	395
Bridges, public	234	4,699	608	1,202	733	888	**8,364**	**103,296**	134,000	50
Earthwork and waterways	180	3,783	4,505	156	6,259	1,112	**15,995**	**221,324**	219,505	....
Streets and roads	1,438	11,789	6,478	7,472	10,829	2,954	**40,960**	**634,335**	598,658	657
Buildings, public	12,880	16,601	41,036	25,414	44,603	35,463	**175,997**	**997,779**	560,113	8,470
Unclassified, public	550	7,482	5,966	21,01	9,470	3,612	**29,181**	**417,841**	161,109	2,032
Total public	**15,423**	**48,525**	**60,060**	**38,022**	**73,733**	**45,371**	**281,134**	**2,525,971**	**1,983,364**	**12,142**
Federal government (included in above classifications)	9,974	18,348	41,332	22,045	54,356	38,341	**184,396**	**1,233,289**	331,541	....
Private										
Bridges, private	....	....	....	....	25	....	**25**	**10,695**	7,277	....
Buildings, industrial	1,721	27,143	935	12,332	6,121	4,697	**52,949**	**545,033**	259,714	3,841
Buildings, commercial	4,898	15,779	3,281	3,835	5,743	2,467	**36,003**	**359,973**	356,101	600
Unclassified, private	420	664	2,635	1,803	4,213	2,878	**12,613**	**146,867**	206,073	....
Total private	**7,039**	**43,586**	**6,851**	**17,970**	**16,102**	**10,042**	**101,590**	**1,062,568**	**829,165**	**4,441**
Total Engineering Construction;										
November, 1940 (4 weeks)	**22,462**	**92,111**	**66,911**	**55,992**	**89,835**	**55,413**	**382,724**	....	....	**16,583**
October, 1940 (5 weeks)	47,884	171,049	136,275	147,200	107,000	93,434	**702,842**	....	....	21,919
November, 1939 (5 weeks)	23,752	118,818	39,363	42,543	50,332	27,407	**302,215**	....	....	7,520
Eleven Months — 1940	**234,549**	**841,256**	**759,632**	**672,590**	**635,863**	**444,650**	....	**3,588,539**	....	**243,266**
Eleven Months — 1939	158,747	924,244	414,965	513,402	507,403	293,768	....	....	**2,812,529**	107,354

HOW WEST CARSON STREET GOT ITS FACE LIFTED—*QUICKLY*



● Laying the top coat of Atlas High-Early on the streetcar-track areaway of Pittsburgh's West Carson Street. Just 72 hours later, normal streetcar service was resumed — a considerable saving in time and overhead over regular portland cement. Contractor: McCrady Construction Co., Pittsburgh.

Only 72 hours after concreting the track area with Atlas High-Early Cement—streetcars go back into service. Result—contractor speeds up whole repairing job.

PENNA. U.S. 30 (LINCOLN HIGHWAY)

PENNA. U.S. 22 (WM. PENN HIGHWAY)

W. CARSON ST. (PITTSBURGH'S W. CARSON ST.)

WEST CARSON STREET in Pittsburgh is also a section of the Lincoln Highway (U.S. 30) and the William Penn Highway (U.S. 22.) You know what it means to repave in the face of frequent streetcar schedules and heavy local and interstate truck and auto traffic.

But the contractors found a speedy solution. They saved many days' time by using Atlas High-Early cement in the streetcar-track areaway. They laid the base course one day. They followed with a 4-inch topping the next day. After curing two days and confirming the strength of the concrete by beam tests, they ran their mixer on the streetcar tracks and started placing the regular portland cement concrete roadway.

Seventy-two hours after placing the track area top coat, streetcars ran freely over the Atlas High-Early concrete. Repaving of the whole street was speeded up tremendously. Quick resumption of streetcar operation helped to reduce automobile and truck congestion.

If you face a street or highway job—the construction of a bridge or a building—particularly a job where speed is essential—specify Atlas High-Early cement. Write today for an informative new folder, "Case Histories of Days and Dollars." Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

• • •

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ENR 11-24

ATLAS HIGH-EARLY CEMENT

A UNIVERSAL ATLAS PRODUCT

The Week In Engineering and Construction

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Difficult to determine extent of public works cut

No major change seen for reclamation and flood control, but President's plan may reduce public building and housing. Highway problem complex

Until the budget is submitted to Congress next year, it will be impossible to tell exactly how much President Roosevelt meant by his statement that nondefense public works will have to be cut next year. At a minimum, it might mean merely that no grandiose projects will be started; this will hit particularly at current proposals for superhighways, inasmuch as the President emphasized that defense projects must really be defense—and Army standards for highways are much below the superhighway level.

Such projects will receive only enough money to do the engineering to bring them up to the construction stage. They will then be put on the shelf, ready to be put underway to provide employment in a post-defense depression. The President's remarks suggested that a definite effort may be made to build up a reservoir of such ready-to-go projects.

Road work financing complex

The situation as regards highway money is very complex. The money which will be spent on the federal-aid road systems this spring and summer was allocated to the states a year ago, has already been appropriated by Congress, and much of it is under contract. This money will not be interfered with at this late date. Money for expenditure in 1942 has been authorized by Congress but not appropriated. Before the first of the year, the Public Roads Administration would normally make a formal allocation of this money to the states; thereafter, it is generally agreed, the allocations become an obligation of the federal government. Although in some quarters it is believed that the President ought to direct that the allocations be held up until Congress can act on an amendment to the highway act, which would defer until next year the decision whether money, materials and men may be spared from the defense program, it is not generally thought that any such step will be taken at this time.

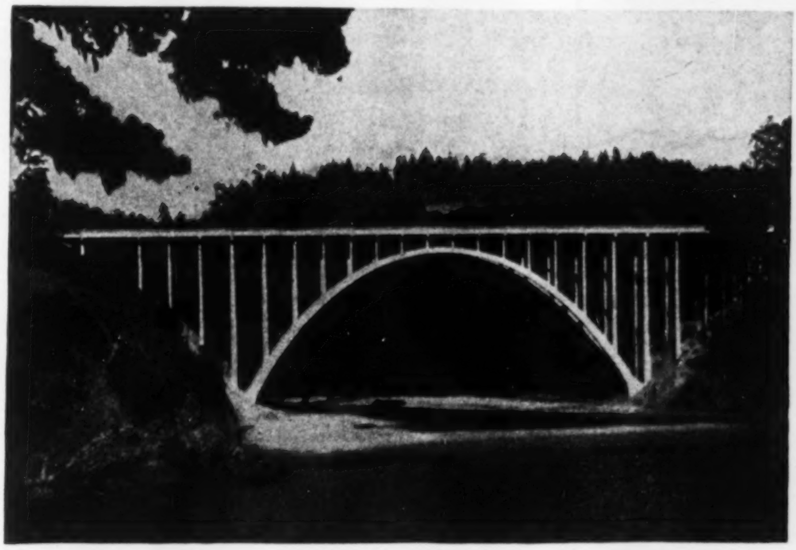
But the first priority on defense roads is access into cantonments and munitions plants; much of this will have to be completed by midsummer, when all the cantonments are scheduled to be in operation. Regular road money cannot well be spent on these roads, both because the states are unwilling to make the necessary matching contributions and because the access roads are generally off the federal-aid system. Some money will have to be found, either through new appropriations or through re-allocation of existing road money.

No major reclamation changes

The Reclamation Bureau, under Presidential direction has refrained with few exceptions from initiating any new projects this past year. There will therefore be no major change in this respect. The big requirement for money next fiscal year will be for continuation of the Central Valley, Grand Coulee, Boulder, and Colorado-Big Thompson projects. Central Valley and Colorado-Big Thompson might possibly be slowed or stopped, since tangible benefits are some way in the future. The other two, mostly involving provision of power facilities, will almost certainly be continued or accelerated; Boulder supplies the center of the airplane industry, and a definite move is underway to locate defense production in the Columbia Valley.

Less public building work

Public building construction outside the District of Columbia will almost certainly be sharply cut. The Public



California arch bridge has 240-ft. span

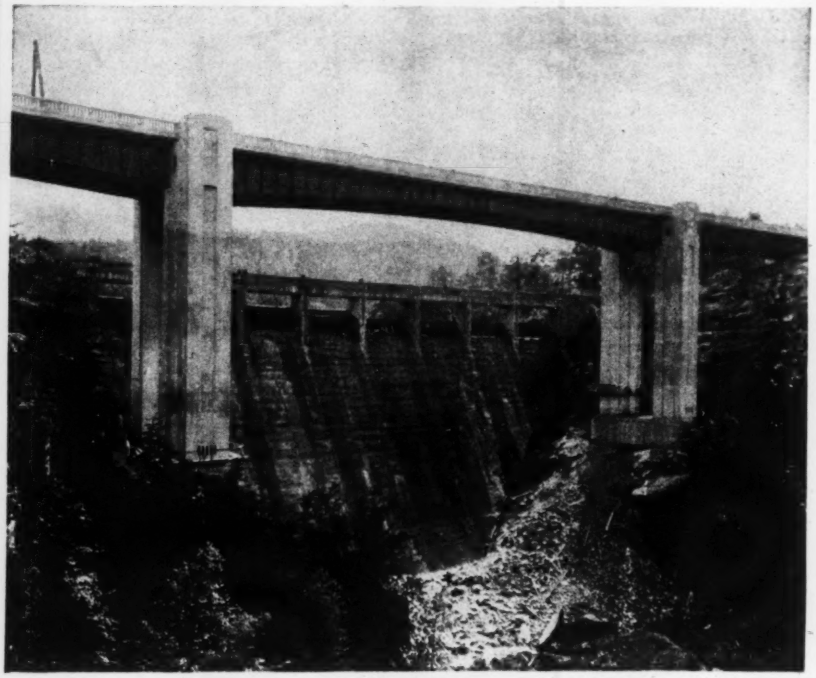
This attractive bridge was recently completed by the California Highway Commission across Russian Gulch some nine miles south of Fort Bragg on the "Shoreline Highway," in Mendocino County. It is an open spandrel arch of 240-ft. span with reinforced concrete girder approach spans. The roadway width is 26 ft. and the overall length is 527 ft. The project included construction of some 2,800 ft. of approaches paved to a minimum roadway width of 24 ft. R. G. Clifford built the bridge and approaches.

Buildings Administration this year is spending the last $30,000,000 of its $130,000,000 three-year program, and there is no indication of a new program. In the District of Columbia, on the other hand, the program will likely be increased to provide for expanding Washington staffs. Most of the work will probably be simple non-monumental structures, though the proposed new Navy Building might be approved.

It will be difficult to cut substantially into general flood control expenditures. Unquestionably the clause in this year's appropriation requiring that 10 per cent of the $70,000,000 available be spent on new projects will be dropped. But many of the projects are of such a nature that substantial physical loss of work already done would be experienced if construction schedules were not maintained. This is in general not so true of river and harbor projects, on which $20,000,000 is being spent this year, and this work will be cut except for a few specifically military projects such as the Delaware River channel. The $45,000,000 now being spent on river and harbor maintenance could hardly be cut very deeply without inconveniencing water traffic.

What infinitesimal chance there might have been of a revival of the PWA program is of course eliminated by the President's plan.

Not quite such a foregone conclusion was termination of the slum-clearance housing program, now admittedly doomed. There had been some administration pressure for more USHA money, but that agency will clearly now be restricted to such defense housing projects as Federal Works Administrator Carmody assigns to it.



Long girders used for Georgia bridge

Providing for a 24-ft. roadway and two 4 ft. sidewalks, the new bridge across the Tallulah River at Tullulah Falls, Ga., makes use of 220-ft. girders for the main span. Side spans are 142 ft. 8 in., making the overall length 505 ft. 4 in. The roadway is 165 ft. above the bottom of the gorge.

The bridge was begun in August 1938, and was opened Nov. 7. Originally the highway was carried across the Tallulah River by means of a 12-ft. roadway on the dam shown.

The 220-ft. girders used for the main span were among the longest in this country when work was started but there are now girder spans of 270 ft. in service. The depth of the Tallulah Falls girders varies from 84 in. at the center and ends of the bridge to 150 in. over the piers. Flange angles are 8x6x7/8 in., total cover plate thickness is 2½ in. and maximum thickness of web plates 5/8 in. The main piers are of cellular reinforced concrete construction, each consisting of two 14x16-ft. columns resting on a common 20x50-ft. base rising some 90 ft. from rock line to top of cap. Additional details are given in ENR *Mar. 16, 1939, p. 392.*

John Monaghan, Inc., Pelham, Ga. with Henry E. Newton, resident engineer, were the general contractors. The Virginia Bridge Co., Roanoke, Va., did the superstructure work. C. N. Crocker, bridge engineer, A. d'Antignac, division engineer, and R. M. Raffensberger, resident engineer, represented the Georgia State Highway Board on the project.

Lanham Act defense housing begins

Building Administration, Navy, and USHA start 10 projects for Federal Works Agency, which starts one itself

First announcement of defense housing projects to be built under the Lanham Act by the Federal Works Agency (as opposed to projects built with the $45,000,000 of Army funds turned over to FWA) was made last week. Three projects totalling 1,900 units were assigned to the Public Buildings Administration—at Indian Head, Md., New London, Conn., and Vallejo, Calif. The Navy will act as agent for FWA in building a 1,000-unit project at Oahu, Hawaii; FWA itself will handle a project at Camden, N. J., of 500 units; and the U. S. Housing Authority will have charge of six projects with a total of 3,350 units. These latter projects are at Jacksonville, Fla., Pensacola, Fla., Charleston, S. C., Philadelphia, Boston, and Bremerton, Wash.

These projects include the first which will be available for employees of private industry—200 employees of the Electric Boat Co. in New London; 1,000 Bethlehem Steel employees in the Fore River shipyard at Boston; and 500 shipyard workers at Camden.

No functional rule

There appears to be no functional rule determining which agency gets which project. FWA spokesmen say that each project is assigned to the agency which it is felt can handle that particular project quickest and best. This obviously applies to the Hawaiian project. Details of the Camden project have not been announced, but it is known that it involves some experimental procedures. And there are strong local housing authorities at all the places assigned to USHA.

Meanwhile, award of four more construction contracts brought to seven the number of Army-FWA projects now underway. None of the projects so far under contract involve demountable or prefabricated construction, but this is still under consideration.

WASHINGTON HIGHLIGHTS

AN IMMEDIATE START of construction on the new Atlantic naval bases acquired from Britain was assured last week when the President allocated $50,000,000 to the project out of his blank check. This will only be a start, of course; the full job will run to a half billion:

It is generally understood that the Navy's overloaded Bureau of Yards and Docks will turn over design and supervision of construction to the Corps of Engineers, which has already established district offices at St. Johns, Newfoundland, and St. Georges, Bermuda. The President has allocated $25,000,000 from his blank check fund for construction of facilities for Army garrisons to protect these bases.

THE CORPS OF ENGINEERS is getting ready to shift its major emphasis from its usual river projects to defense work. Two major jobs have been assigned to it so far—the Navy's new Atlantic bases, noted in above paragraph, and construction of Army airfields. This last is still to be assigned on a project to project basis, but it looks now as if the corps would do most of the work. A considerable part of this will be handled by contract, but there will be some force account work. The corps is not entirely a stranger to airport work; it built Washington's Gravelly Point, and its personnel provided much of the engineering on North Beach and other WPA airfields.

P.C.A. plans long-time study of cement performance in concrete

Program developed by committee of experts will seek to evaluate effects on field structures of differences in cements

In an attempt to raise the accuracy and reliability of predicting the performance of concrete under the rigors of service, a procedure which requires improvement of the correlation between laboratory and field observations and field performance, the Portland Cement Association is about to undertake a long-time study of the performance of cement in concrete. The program to be followed has been developed over the past six months or more by an advisory committee, eight of whose members represent the consumer, while four represent the manufacturers. The committee, whose personnel is given in the accompanying table, will seek, first, the extent to which the performance of concrete is affected by differences in cement, and second, the factors responsible for the same.

In the conduct of the study, field structures will be built by the usual methods, but under close technical supervision, and the cements used will be representative of the whole range of commercially available product. In general, the cements fall into the five types defined by tentative A.S.T.M. Specification C150-40T, plus an extra group to cover specially treated cements (ground with tallow, Vinsol resin, etc.). Attention will be given to the geographical distribution of the producing mills and, in all, 48 cements will be used, totaling approximately 35,000 bbl.

COMMITTEE IN CHARGE OF PROGRAM

From outside the cement industry:

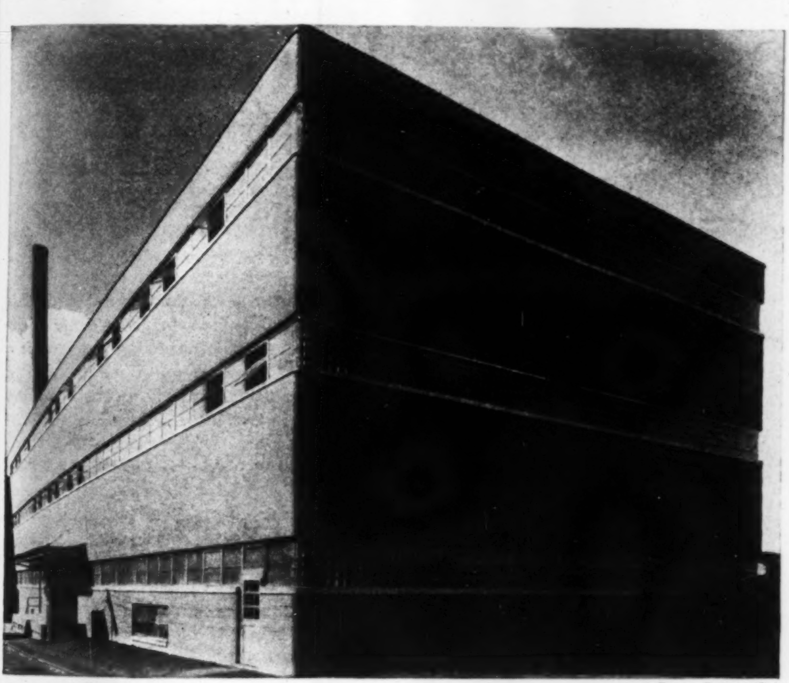
Chairman—P. H. Bates, National Bureau of Standards; Byram W. Steele, Office of Chief of Engineers, U. S. Army; J. L. Savage, chief designing engineer, U. S. Bureau of Reclamation; P. J. Freeman, principal materials engineer, Tennessee Valley Authority; T. E. Stanton, materials and research engineer, California Division of Highways; Roy W. Carlson, Massachusetts Institute of Technology; F. H. Jackson, senior engineer of tests, Public Roads Administration, and R. B. Young, testing engineer, Ontario Hydro-Electric Power Commission.

From the cement industry:

R. G. Uhlig, vice president and operating manager, Missouri Portland Cement Co., St. Louis, Mo.; Hubert Woods, chemical engineer, Riverside Cement Co.; Roy N. Young, chemical engineer, Lehigh Portland Cement Co.; F. R. McMillan, director of research, Portland Cement Association; Ex officio: Frank T. Sheets, president, Portland Cement Association.

These cements, during every stage of manufacture, will be subject to close scrutiny and exacting chemical and physical tests in order that the performance of the field structures as observed over a period of many years may be correlated with the characteristics of the cement. Adequate samples of both clinkers and cements will be stored for use in any future tests that may be devised or seem desirable. In addition, samples will be made available to interested and properly qualified laboratories for cooperative studies.

The field work will consist of projects located in different parts of the country in order that a wide variety of soils, weather and materials will be encountered. Three of the principal projects will be experimental pavements constructed in cooperation with state highway departments in the northeast, south-



Brown-Percy photo

Glass blocks used for Hewitt Rubber warehouse

Recently a new primary department and warehouse building was completed for the Hewitt Rubber Corp., Buffalo, N. Y. The three-story building is of steel frame with brick curtain walls, reinforced-concrete floor slabs, glass block continuous spans for three walls and steel sash for the east wall. The structure, 61 ft. by 183 ft., has all interior walls of facing tile for easy cleaning, and the windows are located high in the walls to provide maximum storage space and natural light. A railroad siding services two sides of the building and a truck unloading platform is provided at one entrance.

The structure was built by the J. W. Cowper Co., Buffalo, D. W. Starkweather, superintendent. H. E. Plumer Associates, Buffalo, are building engineers for the work and E. A. Hoener, Akron, Ohio, consulting engineer. F. E. Manning represented the Hewitt firm.

east and midwest sections of the country. Cements representing the five standard types and the treated cements will be used. Two projects, similar to the above and in conjunction with them, will study variations in consistency and exposure with treated and untreated cements.

Three other projects will study effects of variations in fineness of cement and in burning and cooling conditions of the clinker. These experimental pavements will be private industrial roadways where close control of materials and workmanship will be assured.

One project will be carried out at two locations where the effect of soils high in sodium sulfate and magnesium sulfate, respectively, may be studied. Regular and special cements will be used in concretes of three different cement contents.

One project will study the effect of fresh and sea waters on the six types of cement, using reinforced concrete piles of normal cross-section and lengths. Concretes of different cement contents and consistencies will be tried out also. Exposure will be in the Hudson River, and in the ocean in Maine, Florida and California.

One project will feature the exposure to various conditions of frost and precipitation of concretes containing the standard cements in thin sections in such structures as bridge decks, handrails, and parapets.

One project, using all the cements from the other projects, will study aggregates, mixes and consistencies, in three types of specimens (slabs, walls, columns), exposed to northern and southern climatic conditions.

In all, the program will involve 90,000 sq. yd. of concrete pavement and 2,500 cu. yd. of concrete in structures.

Congress to get report soon on motor vehicle regulation

Interstate Commerce Commission to reveal whether or not federal government should take over control from states

Sometime in March or April the Interstate Commerce Commission will make a report to Congress as to whether the federal government ought to take over from the states the function of regulating the sizes and weights of motor vehicles. It is possible that the report will recommend a specific schedule of sizes and weights.

The study was initiated three years ago under a provision of the Motor Carrier Act. The amendments to this act passed this session of Congress directed that the study be expedited. In recent months five reports on various aspects of the subject have been made by the Bureau of Motor Carriers to the Commission and released by it. A sixth is in preparation. Last month the last of more than 90 briefs expressing opinions on the need for regulation were submitted by states, vehicle operators, railway interests, and others. In general, the states and the railways prefer state regulation, the vehicle users want federal regulation.

The first of the five bulky reports is simply a compilation of existing state regulations. The second is a statistical description of the existing highway system and the vehicles using it; this is drawn from the highway planning surveys carried out by the Public Roads Administration and the state highway departments, and is the first extensive publication of the results of these surveys.

The third and fourth reports are technical studies of the effect of various weight and size combinations upon safety of operation and upon bridges and road surfaces respectively.

The fifth report, upon the legal aspects of federal regulation, concludes that the power to regulate interstate commerce will justify federal action if a need can be shown. It is also pointed out that it would legally be possible so to draft the legislation as to share with the states the regulatory function.

A final report upon the economic effects of size and weight variations is in preparation. Truck operators have been asked to submit to the ICC complete data upon their October operations. From this it is intended to answer such questions as the cost of shipping in different sizes of vehicle, the costs occasioned by varying state regulations, and the like.

Ohio County builds cinder tipples

Franklin County, Ohio, under the direction of County Engineer Allan C. Slade, has built at several points in the county cinder tipples of the type shown above. The construction is to facilitate the distribution of cinders to icy roads during the winter. The cinders will be hauled to the engineer's maintenance garage for grinding and for mixing with calcium chloride before being taken to the various tipples.

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Penn Turnpike extension seen possible

Extension of the 160-mi. Pennsylvania Turnpike from Harrisburg to Philadelphia is "assured" according to Walter A. Jones, chairman of the Pennsylvania Turnpike Commission. This assurance follows considerable time spent by Jones in Washington on the problem of financing the proposed extension. He did not say exactly how the addition would be paid for, but expressed complete confidence in the proposed project.

The chairman has made known that tolls from the superhighway are exceeding engineers' estimates and that this is being used as a selling point in arranging for extension of the highway. Military value of the express route as a link between the Pittsburgh steel mills and the Philadelphia Navy Yard is also being stressed.

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Truck reports unavailable

In *ENR*, Nov. 21, p. 708, it was erroneously stated that reports prepared by the Interstate Commerce Commission telling of motor vehicle size and weight limitations could be obtained from the National Highways Users Conference. In theory the reports can be obtained from ICC, but they are out of print at present.

JOBS OF THE WEEK

REPLACEMENT CENTER, Macon, Ga.

Beers Construction Co., and W. L. Cobb Construction Co., Decatur, Ga., were awarded a $5,434,880 contract for constructing a replacement center at Camp Wheeler for the War Department.

HOUSING, Bremerton, Wash.

West Coast Construction Co. and Western Construction Co., Seattle, were awarded a $1,812,300 contract for constructing a 600-unit low cost housing project near Puget Sound Navy Yard to house workers. Bremerton Housing Authority, Bremerton, is doing the work as a USHA project.

FEDERAL OFFICE BUILDING, Arlington, Va.

George F. Driscoll Co., Brooklyn, N. Y., with a bid of $2,589,420, was low bidder for constructing Federal Office building No. 2, when bids were opened Nov. 26 by Public Buildings Administration.

TEMPORARY BUILDINGS, Fort Ord, Calif.

Morrison-Knudsen Co., Los Angeles, Calif., will construct a temporary building of the cantonment type for the War Department under terms of $5,997,948 contract.

KANOPOLIS DAM, Kansas.

Marsch-Peterson-Walker-Condon, Chicago, Ill., was awarded a $5,632,921 contract for constructing Kanopolis Dam. Contract includes constructing earth dam and excavating for spillway. The dam is being built on Smoky Hill River, Ellsworth County, Kansas. The government estimate was $5,632,921. U. S. Engineers, Kansas City, Mo., are doing the work.

HOUSING, Orange, Tex.

Brown-Lane Co. and Central Contracting Co., Dallas, Texas, are constructing 500 housing units for civilian employees for the Bureau of Yards & Docks, Navy Department, under terms of a $1,480,000 contract.

HOUSING UNITS, Corpus Christi, Tex.

Thomas Bate & Sons, Houston, Tex., are constructing 400 housing units for civilian employees for the Bureau of Yards & Docks, Navy Department, under terms of $1,173,000 contract.

BARRACKS, Fort Eustis, Va.

Dewey G. Weddle & Co., Norfolk, J. P. Pettyjohn, Lynchburg, and Hofheimer Construction Co., Norfolk, were awarded a $5,132,000 contract for constructing the barracks, mess-halls, recreation, and officers quarters for the War Department. J. E. Sirrine & Co., Greenville, S. C., are engineers for the project.

HOUSING UNITS, Pascagoula, Miss.

W. J. McGee & Sons, and The Green Lumber Co., Laurel, Miss., were awarded the contract for constructing 700 housing units for civilian shipyard employees by Bureau of Yards & Docks, Navy Department. The work is estimated to cost $2,000,000.

PIER and TRANSIT SHED, San Diego, Calif.

Mojave Corp., and Persons & Hollingsworth Co., Los Angeles, Calif., got a $1,530,000 contract for constructing a pier and transit shed for the Bureau of Yards & Docks, Navy Department.

PLANT EXTENSION AT SHIPYARD, Philadelphia, Pa.

Cramp Shipbuilding Corp., Philadelphia, Pa., was awarded the contract for the plant expansion by Bureau of Yards & Docks, Navy Department. Estimated cost of the work is $9,000,000.

HOUSING UNITS, Oahu, Hawaii.

E. E. Black, Ltd., Honolulu, T. H., received a $1,717,000 contract for constructing 550 defense housing units near Fort Kamehameha and Hickam Field, Island of Oahu, from the Public Buildings Administration, Washington, D. C. Funds for the project were allotted by U. S. Army to Federal Works Agency.

AMMONIA PLANT, Morgantown, W. Va.

E. I. duPont de Nemours & Co., Wilmington, Del., got a $15,000,000 contract to design, construct and equip anhydrous ammonia plant for the War Department.

FACTORY BUILDINGS, Fond du Lac, Wis.

Klug & Smith, Milwaukee, Wis., was awarded a contract for a group of factory buildings by Giddings & Lewis Machine Tool Co., Fond du Lac. Estimated cost of the work is $2,000,000. F. J. Stepnoski & Son, Fond du Lac, are architects for the project.

NOTE—Additional bidding and contract news on over 800 projects large and small, appear in the Construction News Section beginning on page 127.

New Ohio road head

Hal G. Sours, Akron, has been named director of the Ohio State Highway Department by Gov. John W. Bricker. Sours succeeds Maj. Gen. Robert S. Beightler, who has resigned and is now with the Ohio National Guard at Camp Shelby, Miss.

Since early in 1939 Sours has been assistant director of highways and chief engineer of the department, and when General Beightler left to go with the National Guard he was made acting director.

The new director is a graduate of Akron University with the class of 1916. During the World War he served at Fort Monroe, Va. and advanced to the rank of second lieutenant. During 1919 and through 1925 Sours worked with the Ohio department as maintenance engineer and then as department resident engineer in Summit County. From 1925 to 1937 he was engineer of Summit County.

A year ago Sours was elected president of the American Road Builders Association and only recently was nominated for a second term as president of the organization, election of new officers to come early in 1941 at the New York convention.

Film showing collapse of Tacoma span available

Castle Films, 30 Rockefeller Plaza, New York City, has just released under the title "Super Thrills in the News" a motion picture film showing the destruction of the Tacoma Narrows Bridge Nov. 7. The film, available in 8 mm. and 16 mm. size with or without sound effect, may be purchased for outright ownership from photographic dealers. The cost of the film varies from $1.75 to $17.50, depending upon length and whether or not sound facilities are included. The longer film is expected to run about 12 minutes.

OBITUARY

Peter A. Smith, 55, treasurer of the A. P. Smith Mfg. Co., and chairman of the Joint Meeting, which is an agency representing 12 adjoining communities in northern New Jersey for the purpose of providing sewage disposal facilities, died Dec. 1 in South Orange, N. J.

Robert C. Duthie, 48, employed as civil engineer on the national defense replacement center work at the Fort Francis E. Warren, Cheyenne, Wyo., died in that city Nov. 23. Duthie, a graduate of the University of Colorado.

John W. McKay, 80, who served as engineer for 43 years with the New York City Department of Water Supply, Gas and Electricity, died in Bronxville, N. Y., Dec. 1.

Leo Schultheis, 53, civil engineer who served as a lieutenant in the Ordnance Department, U. S. Army, during the World War, died in New York, Nov. 28.

John P. Eichleay, 64, who organized the John P. Eichleay, Jr. Co. in 1901, which was later succeeded by the Eichleay Engineering Corp., died in Wilmington, Del., Nov. 29.

Charles I. McNeil, 52, surveyor of Crawford County, Ohio, for eight years and former city service director, in Bucyrus, Ohio, died in that city Nov. 26.

Henry B. Bixler, 57, consulting engineer who specialized in the construction of rubber manufacturing plants, died Nov. 26 in Akron, Ohio.

Jedediah Deming, 63, district supervisor of maintenance in the Connecticut State Highway Department, died in Wethersfield, Conn., Nov. 29.

Edward C. Koppen, 61, supervising engineer of the U. S. Bureau of Reclamation, died in Phoenix, Ariz., Nov. 26.

Stewart A. Jellett, Jr., 49, former president of the Stewart A. Jellett, Sr., Engineering Co., Philadelphia, died Dec. 1, in that city.

J. A. Gordon White, 53, field engineer for the Hydro Electric Power Commission of Ontario, died in Toronto Nov. 24.

Michael J. O'Brien, 89, railroad constructor, died at Renfrew, Ont., Nov. 26.

William H. Carson, 63, district engineer for Ontario in the federal department of transport, died in Ottawa recently.

Alexander Georges Sabourin, 64, superintending engineer in the Canadian Federal Department of Public Works, died in Ottawa recently.

John B. Taggart, 78, former engineer of Delaware County, Ohio, died Nov. 25 in Columbus.

CONTRACTS AND CAPITAL

Engineering construction awards for the week, $110,503,000, are 91 per cent above a year ago, the 14th consecutive week in which current totals have topped their respective 1939 values, and are 24 per cent higher than a week ago.

Public construction tops last week by 59 per cent and last year by 144 per cent, while private awards are 39 and 4½ per cent lower, respectively, than a week ago and a year ago.

The week's awards bring 1940 construction to $3,699,042,000, an increase of 29 per cent over the 49-week period last year. Private construction is up 27½ per cent. Public awards are 29 per cent higher than a year ago as a result of the 287 per cent gain in federal work.

New capital for construction purposes for the week, $169,256,000, tops the volume for the corresponding 1939 week by 525 per cent. The highest volume of corporate securities reported this year is responsible for the high total. The week's financing is made up of $148,465,000 in corporate security issues, $20,783,000 in state and municipal bonds, and $8,000 in RFC loans for public improvements.

CONTRACTS

(Thousands of dollars)

	Week Ending		
	Dec. 7 1939	Nov. 28 1940	Dec. 5 1940
Federal	$4,557	$27,411	$68,374
State & Municipal	32,532	29,514	22,395
Total public....	$37,089	$56,925	$90,769
Total private...	20,659	32,378	19,734
TOTALS	$57,739	$89,303	$110,503

Cumulative
1940 ......(49 weeks)....$3,699,042
1939 ......(49 weeks)....$2,870,268

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

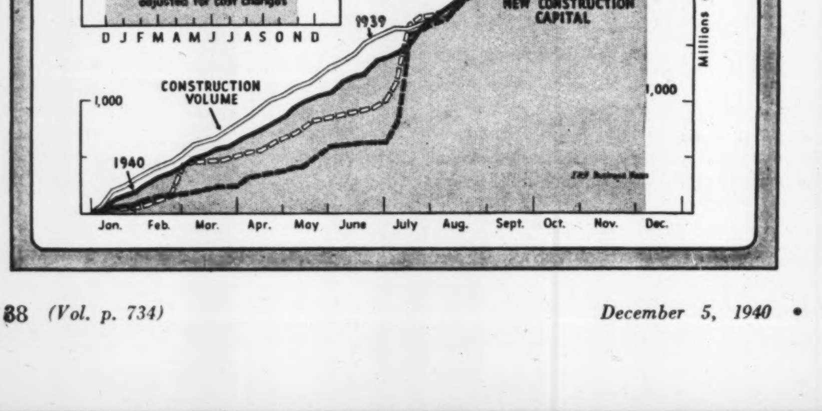
	Cumulative	
	1939 49 Wks.	1940 49 Wks.
NON-FEDERAL	$1,251,999	$1,498,285
Corp. Securities....	208,587	375,105
State & Mun.......	540,107	484,564
R.E.A. loans.......	89,445	40,000
U.S.H.A. loans.....	215,811	218,704
R.F.C. loans.......	8,049	195,912
Fed. Aid-Hwy......	190,000	184,000
FEDERAL	$1,128,028	$2,281,961
TOTAL CAPITAL....	$2,380,027	$3,780,246

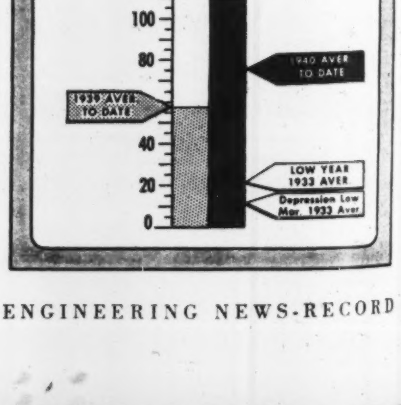
FHA MORTGAGES

	Week Ending		
	Dec. 2 1939	Nov. 23 1940	Nov. 30 1940
Selected for appraisal ..	$19,064	$18,786	$20,559*

Cumulative
1940 ......(48 weeks)....$1,192,504*
1939 ......(48 weeks)....$1,059,837

* Subject to revision.





Nantahala Dam strikers return to work

Construction of the Aluminum Co's Dam at Nantahala in western North Carolina, which was halted Nov. 19 after a day of fighting between northern and southern workers (*ENR*, Nov. 28, p. 721) was resumed Nov. 29, when about 700 workers returned to their posts. Roughly 1,000 workers were employed on the project when the trouble broke.

Settlement of the difficulties followed a mass meeting at the dam site Nov. 28 where Forrest H. Shuford, North Carolina state labor commissioner, delivered an appeal from Governor Hoey urging the men to return to their jobs in the interest of national defense.

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Walkout Delays Work On Colorado Tunnel

A walkout of 100 men employed by S. S. Magoffin, contractor who has the eastern 8,600-ft. section of the 13-mil. Bureau of Reclamation Colorado-Big Thompson tunnel, tied up construction on the work from Nov. 23 to 29 inclusive. The controversy centered around one of the contractor's foremen who the AFL unionists workmen declared had been previously involved in anti-union activities on the West Coast. In addition a grievance committee complained of working conditions, including ventilation and washroom space. The entire matter was quickly settled without difficulty and work resumed on Nov. 30. The contractor has a closed shop agreement with the union.

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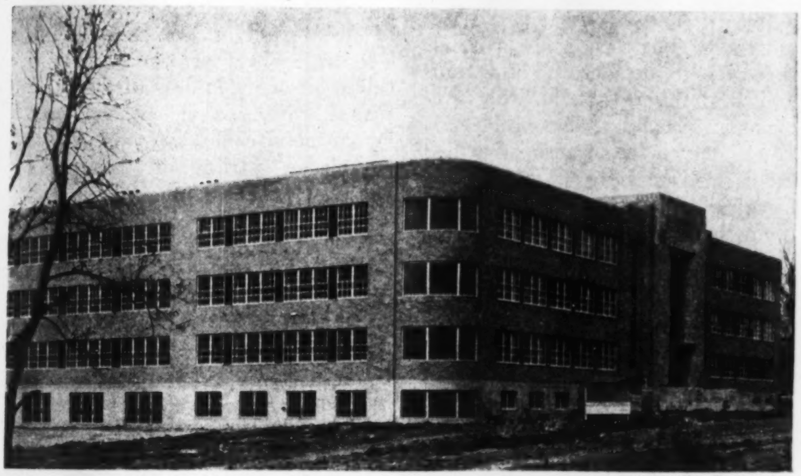
Oklahoma City water bonds held valid

The Oklahoma State Supreme Court has held the $6,911,000 bond issue voted by the city of Oklahoma City for waterworks purposes to be valid. Opponents of the issue have indicated that the case will be filed in the federal courts and that further litigation is to be expected.

The bond issue was approved by a margin of 396 votes Feb. 20. It calls for the construction of the Bluff Creek reservoir and a new filter plant, together with extensions and additions to the present distribution system. The election climaxed a long campaign for waterworks improvements in Oklahoma City, which has had several water shortages during the past few years.



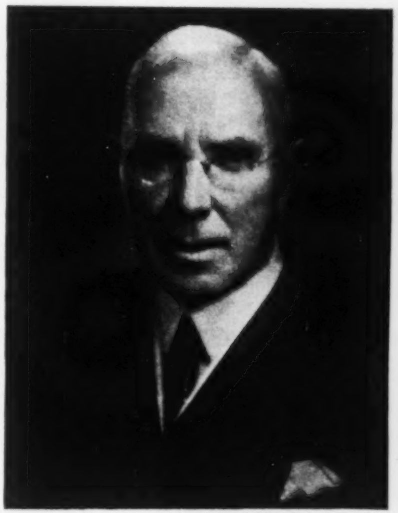
Caterpillar Tractor photo

First agricultural regional laboratory completed

The first of four regional laboratories provided by the Agricultural Act of 1938 for the U. S. Department of Agriculture is nearing completion at Peoria, Ill. This building will serve 12 states in the north central region. The structure, entirely fireproof and air conditioned, is three stories high. It is U-shape in plan, with a front of 211 ft. and two wings each 306 ft. long. The purpose of the laboratories, defined in the 1938 Act is "to conduct researches into and to develop new scientific and technical uses and new and extended outlets for farm commodities and products."

The Peoria laboratory is off to a good start, for in the grading and landscaping of the grounds crude soybean oil has been tried out as fuel for a Caterpillar diesel tractor and bulldozer under the direction of O. E. May, director of the laboratory, and P. B. Jacobs, senior chemical engineer. Utilizing the soybean fuel, the tractor started, performed and operated the same as with fuel oil, and also maintained its full power; combustion was complete. Soybean oil weighs 7.7 lb. per gal. and produces about the same power per lb. as does diesel fuel oil. May has already stated that "possibility of the production of agricultural motor fuels will be intensely investigated."

The building was constructed by the W. E. O'Neill Construction Co., Chicago.



Ashley & Crippen photo

Toronto dean retires

Retirement of Brig. Gen. Charles Hamilton Mitchell, dean of engineering at the University of Toronto, has been announced by H. J. Cody, president of the University. Dean Mitchell will continue his duties until the end of the present academic session, his official date of retirement being June 1941; he will then have served as dean for twenty years, the longest tenure of office of any of Toronto's deans of engineering.

He is a past president of the Engineering Institute of Canada, has served for many years as a consulting engineer in Toronto, and was a member of the Canadian Board of Engineers studying development of the St. Lawrence River.

Another consultant board named for Tacoma span

The Washington Toll Bridge Authority recently named a three-man board of engineers to estimate damage to the Tacoma Narrows suspension bridge, which collapsed Nov. 7. The board—composed of Francis Donaldson, chief engineer for Mason-Walsh-Atkinson-Kier Co. for 1½ years on Grand Coulee Dam; L. J. Sverdrup, of the consulting firm of Sverdrup & Parcel, St. Louis; and Russell G. Cone, engineer for the Golden Gate Bridge & Highway District—will aid the authority in making its claims to the insurance companies.

Last week in these pages we made mention of the appointment by the Public Works Administration of a three-man board to study the failure. The members of that board are: Othmar H. Ammann, director of engineering, Port of New York Authority; Theodore Von Karman, director of the Daniel Guggenheim Aeronautical Laboratory at California Institute of Technology; and Glenn B. Woodruff, engineer of Berkeley, Calif., employed on the design of the San Francisco-Oakland Bay bridge.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

TACOMA NARROWS COLLAPSE

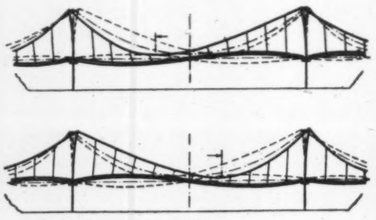


FIG. 1

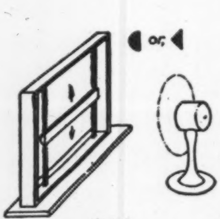


FIG. 2

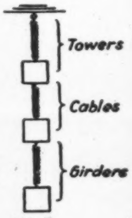


FIG. 3

Sir:—Dr. von Kármán's analysis of the Tacoma Narrows Bridge oscillation (*ENR*, Nov. 21, 1940, p. 670) appears to be based not only on the assumption of the fundamental mode, as pointed out by the Editor, but also on the premise that the transverse deck tilting or twisting was due primarily to a *lateral* swinging or pendular oscillation of the girder and cables. Judging from the news-reel moving pictures, descriptions in the technical press and models constructed by the writer to duplicate the motion, the mode of oscillation both before and on the day of the collapse was quite different from the above assumption. Descriptions so far appear to establish the following facts:

1. The amplitude of oscillation was not proportional to wind velocity. Large movements had been observed in relatively mild wind, and lesser motion in stronger winds.
2. The lateral transverse motion or swinging had always been practically negligible. Just before the collapse the lateral motion was observed to be about 2 ft., which is quite insignificant in a span of 2,800 ft. The motion was always predominantly vertical.
3. Prior to Nov. 7 the girder motion was vertical and undulating, both sides of the girder moving up and down in unison, but the span oscillated in two loops with a node at midspan, the portions on either side moving in opposite phase. The period of this motion was reported to be about 12 sec.
4. On the day of the collapse, the mode of motion started off as usual, but rather suddenly the twisting mode developed, the sides of the girder moving up and down in opposite phase, as well as the two halves of the main span, with a faster period of about 4 sec.
5. The two cables were executing longitudinal "rolling" or pendular oscillations, which, just before the collapse, were also in opposite phase. This gave rise to the angular twisting motion of the deck, as illustrated by the accompanying sketch, Fig. 1.

Dr. von Kármán's analysis would not account for the excitation of the parallel, undulating motion observed in the past, when no twisting existed, and probably has application only in a secondary way when the twisting did set in. But such analysis is not necessary to demonstrate how self-excited vibration is set up with aerodynamic instability. The problem is an old one on long transmission line catenaries, and also in high speed machinery, where fatigue failures occur in blades and vanes due to flutter.

Fig. 2 represents a simple, highly instructive model that can be made for a few cents, described by Prof. J. P. den Hartog.* The fan, aimed directly at the flat surface of the elastically suspended half-round bar, gradually causes it to execute violent oscillations in the vertical plane. Modifications such as flanges along the upper and lower edges, bent *into* the wind, may increase the effect (simulating the top and bottom cover plates on the stiffening girders). After observing the action of this model one would incline to the belief that no further explanation is necessary to account for either the parallel or the twisting undulations. The model cannot be made to oscillate with the round side toward the wind.

The dynamic characteristics of the Tacoma Narrows Bridge are far different from the earlier, heavy, stiff truss constructions. The ratio of its cable mass and stiffness to the girder or truss mass and stiffness is a much greater figure. In this construction the cables themselves assume a far greater importance; they may even be thought of as "manhandling" the girder, even though the latter may supply the major aerodynamic forces exciting the movements.

An analysis leading to an equation of motion for the structure as a unit must recognize three elements, each with its own inertia and elastic characteristics in the twisting mode of oscillation assumed: the towers, the cables (with both gravity and elastic restoring forces), and the girder. Such a system may be represented crudely by the ideal arrangement illustrated in Fig. 3.

Why the twisting motion should have suddenly set in when it had not been experienced before is not clear. Some sudden change in the dynamics of the system is indicated—either rupture of some girder members due to the previous motion, or the sudden letting go of the hold-down cables on one side only of the shore span, throwing a violent snap-back in one main cable, and one side of the girder, starting off the out of phase movement of the cables first, and then the girder, causing the twisting motion of the girder. Once started, it would of course build up rapidly, probably now aided by the forces described in Dr. von Kármán's analysis.

T. C. Rathbone
Chief Engineer, Machinery Division
The Fidelity and Casualty Co. of N. Y.
America Fore Group of Insurance Companies

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* Transmission-Line Vibration due to Wind and Sleet, Trans. A.I.E.E. Vol. 51, December 1932, paper 32-91, p.1074. See also:—"The Calculation of Dampers for Systems Subject to Self-Induced Vibration" J. C. Baker and S. J. Makina, ASME meeting at Pittsburgh, June 1936, and "Studies on Conductor Vibration," Leonard G. Peskin, Edison Elec. Inst. Bulletin, August, 1939, also "Self-Induced Vibrations", J. G. Baker, Trans. ASME, Vol. 55, 1933.

Sir:—Roebling, in his long suspension bridges with narrow roadways, spread the tower supports and cradled the cables for lateral stiffness. The towers of the Tacoma Bridge present an effort to achieve architectural limberness in lieu of engineering rigidity by triangular bracing. An effort to rebuild the floor with latticed stiffening trusses would achieve another crack-up. The right and left roadways should be spread outside of the tower rather than passing within the tower. The spread roadways would form a wind chord, and floorbeams at 30-ft. intervals would enable the structure to be braced efficiently against lateral pressure.

Stiffening a long-span light suspension bridge may be done efficiently by following the suggestion of Sir Thomas Bouch in his preliminary sketch for the Firth of Forth Bridge. He proposed to tie the cables down to a circular curve by stays from the tower slanting upward instead of downward as in the Brooklyn Bridge. Such an arrangement with the stays pulling against a box stiffening girder continuous from tower to tower rigidly attached to the cables at midspan and sliding at the tower would result in a statically determinate system for the analysis of the stress on the stays. The bending on the stiffening girder would be reduced five-sixths by the stays.

Uplift from wind pressure, which wrecked the high bridge at St. Paul 35 years ago, was such that a corner of a long heavy span was lifted from its support and a large portion of the structure wrecked. Such an uplift at Tacoma can be prevented by a few stiff hangers connected with the cable at the intersection of the suggested stays. Thus a rigid structure may be developed, utilizing the present cables and towers.

C. A. P. Turner
Consulting Engineer, Columbus, O.

Sir: There is a misstatement in the first news report on the Tacoma bridge failure by N. A. Bowers (*ENR*, Nov. 14, 1940). On p. 10 he says, "It was by far the most slender suspension bridge ever built, both laterally and vertically." It is true that the Tacoma Narrows Bridge was the most slender bridge laterally, but it was not the most slender bridge vertically. That honor goes to the George Washington Bridge, which has no stiffening girder whatever. It has a wind chord, but no vertical stiffening girder.

Harold E. Wessman
New York University, New York, N. Y.

Contractor-WPA Work in Texas

Sir: It was noted with interest (*ENR*, Sept. 26, 1940, p. 409) that the State of New Jersey during the past two years has completed a $6,000,000 highway program which involved contract work in which WPA cooperated with the state highway department.

The Texas State Highway Department was, in so far as we have been able to learn, the first public body in the United States to inaugurate contract projects in which WPA participated. The Texas State Highway Department, late in 1938, commenced a study of contract procedure as it could be applied to projects in the construction of which WPA facilities could be used to an advantage. As a result of this study, special provisions were prepared for use in all contract documents for SHD-WPA operated contract projects. These special provisions provide in general that the contract is distinctly between the state highway department and the contractor, with WPA not being in any sense either directly or indirectly a party to the contract. The provisions further provide that WPA will expect to furnish to the contractor without cost to him a certain number of man-hours of unskilled labor, a certain number of man-hours of intermediate grade labor divided among the several classifications which may be used in the project, and also certain materials—the quantity of which is estimated and the location of the delivery points given. The provisions also state that it will be the responsibility and the duty of the contractor to supervise the activities of all labor furnished by WPA from the time the labor reports to the contractor either at a designated concentration point or at the site of the project. The WPA's interest in its labor during the period of the work day is to the extent only of ascertaining that the labor is not required to work under dangerous or hazardous conditions; that it is usefully employed; that it does not work out of classification.

WPA normally furnishes one representative who has a title of "Superintendent" and who is usually experienced in construction work from the standpoint of a contractor's operations. There is also furnished the necessary number of timekeepers and such other personnel to enable the preparation and keeping of such records as WPA may desire. In most cases the WPA representative in no way acts in a supervisory capacity nor does he attempt to direct the actual operations of the WPA workmen.

Recently, the contractors on the projects in which WPA participated have found it advantageous to use Grade "C" foremen furnished by WPA. In many instances, it has been found that WPA workmen are better satisfied if working under the immediate direction of a WPA labor foreman. Of course, the labor foremen, or Grade "C" foremen, receive all instructions as to the work from the contractor's superintendent.

During the period of time that SHD-WPA projects have been operated by the Texas State Highway Department, there has been undertaken a total of 94 projects for which the highway department contributed $4,224,025 and the WPA $1,749,462.

The application for a SHD-WPA operated program is made state-wide, designating in the application the County, Highway and the approximate cost of the improvement to be undertaken on each individual project. The program has been made extremely flexible, in that projects may be removed from the state-wide application or new projects added merely by submitting a proper request to the State WPA Office. In the case of deletion of projects, it is only necessary to submit a letter stating that for some reason—usually that the construction of the project does not readily lend itself to WPA participation—it is desired to eliminate such and such items from the program operated under a certain O.P. Number. In order to add additional projects, it is only necessary to prepare WPA Form O-19, giving the estimated cost of the project distributed between SHD costs and WPA costs, together with an estimate of the total number of man-months of work involved.

The fact that the number of bids received on SHD-WPA projects is equal to, or higher than, the average number of bids received for either straight state or regular federal aid projects indicates that Texas contractors look with favor upon constructing this kind of project. A general average of a large number of contract projects which have been constructed, or placed under construction in Texas, indicates that of the total cost WPA participation of 30 to 40 per cent can be expected. Where projects involve a large amount of concrete work, and especially if the structures are small drainage structures or the extension of old drainage structures, WPA participation will be higher.

D. C. Greer
State Highway Engineer, Austin, Tex.

EDITORIALS

VOLUME 125 NUMBER 23

December 5, 1940

Toward Better Concrete

ONE THING of which the promoters and proponents of concrete construction can be proud is their record of constant criticism of their own product. And by keeping concrete in a continual state of clinical unrest, as it were, they have been able to make it better and better. Research, however, seldom has an end point, each discovery in one direction pointing to the need of more knowledge along some other line of study. Concrete researchers, for example, having exhausted, relatively at least, the possibilities for new tests involving water ratios, aggregate soundness, proportioning and placing methods, are turning to the principal ingredient, cement. Those who have felt that such studies are long overdue should take satisfaction in the type and scope of investigation that the Portland Cement Association has initiated. As reported in the news pages of this issue, the investigation has a clear-cut practical objective—to determine the extent to which the performance of concrete is affected by differences in cement and to single out the factors responsible for such differences. What about the cement? has become the most insistent question in the minds of concrete users seeking an answer to the frequent unreliability of their predictions on concrete durability. The careful research program that has been laid out represents a splendid start in the quest for an answer.

Look Below the Surface

THE ADAGE "A little knowledge is a dangerous thing" applies literally to subsurface investigations at the site of engineering work. Even when danger of structure failure is not involved, danger of cost increases by virtue of redesign or extra work is always present where foundation knowledge is scanty. If the contractor must take full responsibility for the satisfactory completion of the work, as is most often the case, he guards himself by high contingency allowances in his bid. If redesign is necessary the contractor is entitled to extra compensation. In any event the owner saves nothing by skimping on subsurface investigations before the job starts. All this is well known, but it receives current emphasis from the good results of careful subsurface exploration on New York City's Delaware Aqueduct. Very few unexpected difficulties were encountered on the 85 miles of tunnels, while on the Merriman Dam work of this project, described in this issue, nothing has been left to chance; two exploratory caissons, designed to form part of the cutoff wall, were sunk so that exact foundation conditions would be known to the bidders on the remainder of the work. It is significant that redesign and extra charges on all of the aqueduct work are at a minimum. It pays to look below the surface.

Roads for Defense

LAST WEEK the President announced that drastic cuts were to be made in all federal expenditures not directly involved in the defense program. He specifically cited public works expenditures and intimated that only those absolutely essential to defense would be allowed to go ahead. It is believed that this budget paring will not affect the normal federal-aid highway program, since its value to national defense has never been questioned. On the other hand recent attempts to secure 100 per cent federal appropriations for certain special highway and parkway projects under the guise of national defense needs are not looked upon with favor in Washington, and their continued promotion could react badly against the normal federal-aid program. Most of these special projects are not justified as national defense undertakings. Few of them fit into the plans for a comprehensive system of national highways, useful alike in peace and in war. Practically none of them could be completed short of two years. Continued efforts to force appropriations through the next Congress to cover the cost of these isolated local highway and parkway projects on the ground that they are necessary to national defense seems certain to raise opposition. The result could be budget cutting on the normal federal-aid program, which might well create a real obstacle to our preparedness effort. It is to be hoped that the President recognizes this. And it is also to be hoped that defense roadbuilding will not suffer from its friends.

Invitation to Blight

TWO DECADES AGO zoning of large cities was done largely on other than the yardstick basis of necessity. Today zoning for business can be done strictly on a factual basis of need. Detroit, the only large city without zoning, is just now in the throes of putting a zoning ordinance on the books. It is experiencing the familiar pressure of special real estate interests to increase the business zones way beyond reason. Specifically 20 blocks of streets facing three sides of the $11,000,000 Herman Gardens housing project are about to be zoned for business. This amount of frontage is stated to be three to four times too large and will inevitably result in a stringy development of hot dog stands and saloons much to the detriment of the project and the surrounding residential territory. Housing authorities in Detroit as elsewhere have provided within their areas space sufficient if not excessive for all the stores needed. With the sad experience of Chicago, and practically all large cities, in overzoning for business to guide it, Detroit has little excuse at this late date for not recognizing—and avoiding—one of the greatest of slum-producing factors, namely oversize business zones.

Suspension Bridge Research

THE INTENSITY OF INTEREST in the Tacoma Narrows bridge failure and the extent to which this interest has spread could not have resulted from anything limited solely to or centering exclusively in one remote structure. Such widespread interest arises from causes much more fundamental, namely, the desire for full reassurance about suspension bridges now in use or proposed for construction.

The conscientious city official may reason something like this: "We are convinced that our bridge is safe, but how can we prove it, and what steps should we take to check with the new theory said to have been discovered when that bridge failed out in the Northwest?"

Such anxiety is, of course, both natural and proper. Since the accident showed that under certain conditions well known laws of fluid mechanics apply to suspended structures, it becomes necessary henceforth to give consideration to energy and elastic movements in such structures where heretofore we have been content to consider only forces and static resistance.

Fortunately the aerodynamic forces involved have been explored extensively in recent years, thanks to airplane design. Dr. von Karman at California Institute of Technology has done outstanding work in this line. The Army, the Navy and various airplane manufacturers have developed standards by which to apply the basic principles involved, and in scores of laboratories and plants wind tunnels are now in use for further study of wind resistance and structural reactions.

Just how can we develop the data and design principles needed for applying these laws to suspension bridge design? The wind tunnel will doubtless figure prominently and is the logical starting point for analyses because it gives something definite on which to base further study. However, even while we rate it the most dependable starting point, the wind tunnel should not be relied upon exclusively. Air flow in wind tunnels is accurately regulated and directed; in nature, wind may be gusty, its direction with respect to a fixed structure is sure to shift, and the resultant forces are almost certain to be affected by factors wholly absent in wind tunnel tests. Thus, laboratory findings will need to be supplemented by data relative to the effect of wind on bridges actually in service. Instrumental observation on the structures themselves can be of immense value in interpreting characteristics. In short, theories suggested by wind tunnel data should be studied, checked and tested full scale before final conclusions are made.

In long suspension spans, stiffness is a vital factor in preventing the sort of wave motion that was destructive at Tacoma Narrows. Perhaps a "stiffness ratio" or some such basis for comparison of this characteristic would be useful. Attention should not concentrate on the suspended structure alone—there may be important relationships to movement in the main cables themselves. Doubtless numerous aspects of elastic analysis new to bridge design will appear as the studies advance.

Finally, nothing should be done to discourage or dissuade any who are equipped for research in this field. At the same time it would be unwise not to provide some clearing-house through which all such information can be made generally available. A logical starting point would be a national committee to program and outline desirable lines of research, in both laboratory and field, covering all phases of wind action and the behavior of bridges of various proportions and characteristics. The opportunity for research should not be missed but guidance and inspiration are needed.

ENGINEERING NEWS-RECORD

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EDITORIAL OFFICES, 330 WEST FORTY-SECOND STREET, NEW YORK, N. Y.

Influence of Air Conditioning On Structural Design

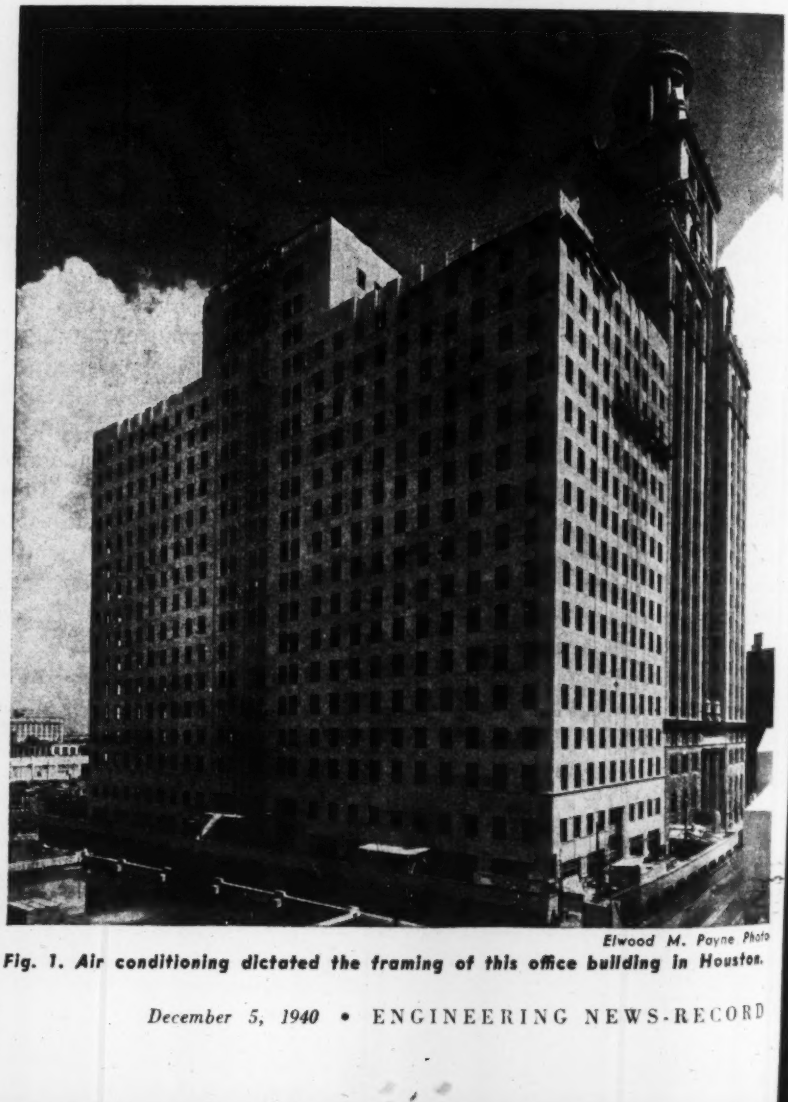
Walter H. Weiskopf
Weiskopf & Pickworth, Consulting Engineers
New York, N. Y.

***Contents in Brief**—Complete air conditioning of Houston's newest skyscraper was a controlling factor in the structural design. Increased headroom for ducts was provided by making the width of one bay of steel relatively narrow, permitting shallow floorbeams; wind connection capacity for these beams was obtained by end stubs that did not encroach on duct space. A one-way concrete joist floor eliminated longitudinal beams that would have blocked the air inlets from ducts to offices.*

PROMINENT RECENT ADDITION to the business center and skyline of Houston, Tex., the 16-story Mellie Esperson Building is significant to structural engineers as an illustration of how modern air conditioning systems affect the structural design. In this building both framing and floors were substantially varied from designs that could have been used if air conditioning had not been a requirement.

This new office building is L-shaped, the longer leg of the L extending 252 ft. on Walker Ave., from Milam St. to Travis St., and the shorter leg extending 97 ft. on Travis St. It is 16 stories high except for a tower at the center of the Walker Ave. leg, which extends 3 stories higher and is surmounted by a large concealed cooling tower. At the end of the Travis St. leg of the L, connection is made to the Niels Esperson Building, which was built in 1925. The two buildings, however, are treated quite differently from an architectural point of view. The older Niels Esperson Building is ornate Italian Renaissance in style, while the new structure is modern in its simplicity.

In plan, the typical floor has a 6-ft. center corridor extending the full length of both legs of the L, with offices on both sides as shown in Fig. 2. The elevators, stairs and service shafts are near the center of the Walker Ave. portion. The air conditioning system takes in fresh air at the second floor at the rear and passes it through a cooling and dehumidifying plant in the basement. From there it is sent up to the various floors through a distributing tower located behind one bank of elevators. In this tower, besides the main ducts, are numerous fans to control the amount of air delivered to the various zones on each floor. Ducts in the space over the corridor ceiling deliver fresh air to the individual offices. The air returns through grills in the partitions and through the corridor itself to the distributing tower and thence to the basement, where, mixed with fresh air, it is conditioned for recirculation. The supply ducts over the corridor ceiling, with their out-



Elwood M. Payne Photo

Fig. 1. Air conditioning dictated the framing of this office building in Houston.

lets supplying the various offices, had to be considered in the structural design.

Two lines of columns dividing the width (59 ft. 6 in.) into three bays, was a logical arrangement. The center bay was made slightly smaller than the two outside ones in order to hold the depth of the girders over the corridor ceiling to a minimum.

For such a regular plan, with so many approximately square adjoining floor panels, a two-way concrete joist floor construction was first considered as being economical. The necessary longitudinal girders between the interior columns, however, blocked the supply of air from the ducts in the corridor ceiling to the individual offices. To eliminate these girders, a one-way concrete joist floor construction was studied, with joists placed parallel to the corridor. Such an arrangement permitted shallow tiebeams between the columns, and since these beams were contained in the floor construction they allowed the unobstructed passage of air from the ducts above the corridor to the offices. In the other direction girders in the two outside bays were not objectionable and in the center bay were kept as shallow as possible to leave the maximum space over the corridor. For a building of this height wind bracing had also to receive consideration and this arrangement provided girders across the building in the direction required.

Study of vertical loads and wind moments showed that for the girders in the typical floor 18-in. wide flange beams were economical and that the wind bracing connections could be top and seat angles for the upper floors and split-beam tees for the lower ones. These details are placed inside the fire-proofing with practically no encroachment beyond the beam and column flanges.

In the center bay over the corridor, where it was desirable to keep the girders as shallow as possible, it was found that 12-in. wide flange beams were strong enough for the vertical load. However, in order to maintain the same type of wind bracing detail, the depth of these pieces was increased to 20 in. at the ends by riveting 8-in. wide flange stubs to the bottom flanges. These stubs did not extend into the corridor, as shown on Fig. 2, and therefore did not interfere with the ducts.

As was mentioned above, the floor construction consists of concrete joists extending parallel to the legs of the L. The joists were formed by steel pans, and generally the top of the slab was floated to serve as a finished floor. In the elevator lobby and corridors the joist construction was lowered 2½ in. for a terrazzo finish. The walls on the street fronts consist of 4 in. of limestone backed up with 8 in. of brick. The rear walls are 12-in. brick selected to match the adjacent Niels Esperson Building. Foundations consist of large reinforced concrete footings which spread the column loads to a sufficiently low soil pressure for the stiff clay typical of this region.

The structural frame was erected in about 8 weeks, and in 9 weeks more the floor system was completed. The wall construction followed promptly, and in another month that also was topped out. The building is scheduled to open in February, 1941.

John and Drew Eberson of New York City were the architects, for whom the air conditioning system was designed by Charles Leopold of Philadelphia. The structural frame and foundations were designed by Weiskopf & Pickworth, consulting engineers of New York. The general contract was held by the American Construction Co., Houston, for whom the steelwork was furnished by the Mosher Steel Co., also of Houston.

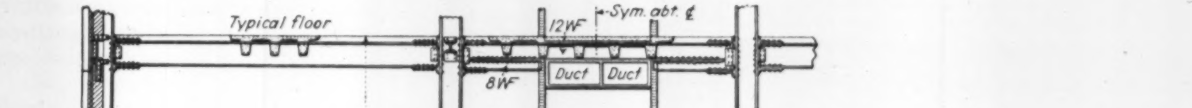


Fig. 2. Structural framing of Mellie Esperson Building reflects effect of air conditioning. Central corridor bay is narrower than outside bays to obtain greater headroom for ducts. Special stub windbracing for beam in this bay clears ducts.

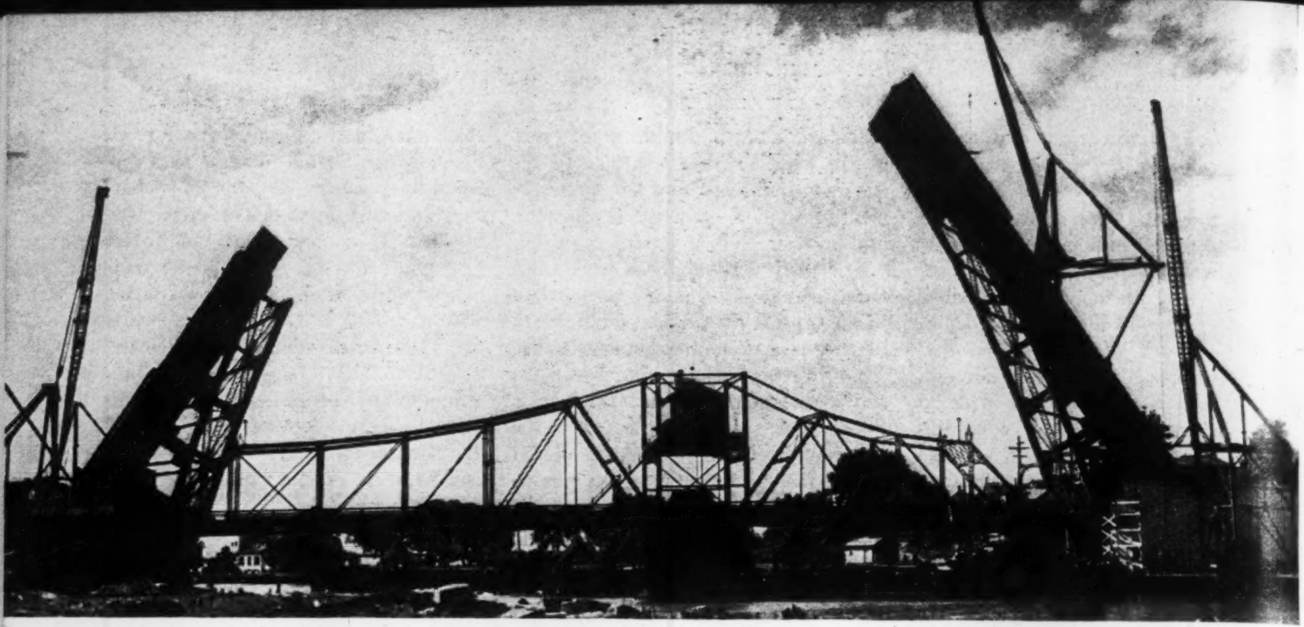


Fig. 1. At Lorain, Ohio, two derricks erect each bascule leaf to complete record 333-ft. highway span.

Lorain Bascule Sets New Span Record

Contents in Brief—*A 333-ft. four-lane double-leaf bascule bridge replaces a narrow highway swing span at Lorain, Ohio, improving navigation for long ore boats by elimination of the center pier. Close clearances required by alignment near the old bridge forced operating machinery into the center of each pier. Limited room for the counterweight was overcome by use of iron ore as aggregate for concrete. Unexpected foundation troubles were solved by driving steel H-piling to hard shale.*

LORAIN COUNTY, OHIO, has completed what is believed to be the longest trunnion bascule highway bridge in this country. It is 333 ft. center to center of trunnion pins and 295 ft. face to face of piers. Although the clear ship channel is only 180 ft. wide because of the skew of the roadway with the river, this represents a considerable improvement over the low swing bridge that it replaces, whose 100-ft. opening complicated the movement of ore boats to docks and smelters on the upper Black River. The new structure provides 33 ft. of vertical clearance near the centerline eliminating the necessity for opening the bridge for tugs and small boats. The entire project is 1,050 ft. long, half of which crosses a low plain westerly from the river with continuous plate girder spans varying from 56 ft. to 90 ft. in length to accommodate clearance requirements of existing railroad tracks. Easterly from the bascule a single 69-ft. span joins the natural ground. The deck carries two 22-ft. roadways separated by a 3-ft. center island and a 7-ft. cantilever-supported sidewalk on each side of the bridge. The approach span deck is a concrete-filled steel grid of about 6x6-in. pattern, the concrete being finished flush with the top of the steel. On the bascule span open-grid steel flooring is used.

Several features of the bridge are unique. Very scant working room, due to necessity for maintaining the old bridge until completion of the new, did not permit placing machinery outside the minimum lines required to house the structure, so all operating machinery is located within the piers immediately below the trunnion bearings. This position makes mechanical synchronization simple, both racks being driven from pinions on the same shaft. Driving power for each leaf is normally two 100-hp wound-rotor induction motors, operating at full normal load but either motor can open the bridge by operating at overload for a short period. Emergency power is provided by a 130-hp gasoline engine capable of mechanical connection to the gear train and equipped with an a.c. generator direct-connected to the driveshaft having sufficient capacity to motivate the auxiliary motors operating the gate locks and signals.

Placing the drive mechanism under the movable leaf reduced the available room for counterweight and made "heavy" concrete a necessity. Weight was added by the use of hematite iron ore for both fine and coarse aggregate, readily available at the local ore port, and by the addition of steel punchings to bring the concrete up to the required weight of about 184 lb. per cu. ft. The concrete contained 6.3 bags of cement per cubic yard.

Deck grades on the two leaves of the bascule are not the same and the elevation of the trunnion pins differ by about 3 ft. However, the steelwork for both is designed identically to cheapen fabrication and the variation is taken up by adjusting the travel limits of the respective leaves, though each leaf travels through the same arc. Some minor adjustment near the junction is taken care of by shims under the structural floorbeams. A positive lock is provided to keep the bridge in the down position as wind uplift, computed at 70 per cent of a solid surface for the open grid, indicated possible forces sufficient to raise the leaves.

The weight on the 29-in. trunnions is about 800 tons, of which 575 tons is counterweight. Trunnion pinions and shafts are SAE 2135 chrome nickel steel with a Brinnell hardness of about 300. Racks have chrome vanadium 6½-in. pitch circular gears.

Foundations

The bridge and its approaches span a clearly defined pre-glacial river-bed. Shale of bearing quality is about 70 ft. below normal water with the overlying material a mixture of soft black disintegrated shale, boulders, and debris (too unstable to permit securing a core) with the top few feet of sand, gray clay and fill. The hard shale bed rises quite sharply at the banks, the edges of the ancient river-bed, and the position of the new bridge is such that under the easterly river pier good bearing material is only 20 ft. below normal water, while under the westerly river pier it is about 90 ft. Thus the design and construction were substantially different on the two sides of the river.

The easterly pier was built inside a sheetpile cofferdam driven to an excellent seal in the higher shale available. On the river side of this pier the piling is driven several feet below the footing and will be left in place to prevent exposure and scour when the channel may be deepened to 5 ft. below the pier base, providing 25 ft. effective depth of waterway. Weight of the partially hollow pier is sufficient to counterbalance the full uplift pressure of the water so no provision is made to regulate the hydrostatic pressure under the slab.

The westerly pier was originally designed to be supported on concrete-filled 8-ft.-diameter caissons under the live load and anchorage columns, near the four corners of the pier, and 12-ft.-diameter caissons under the trunnion bearings. Sinking of the circular plate caissons was to be done inside a rectangular sheetpile cofferdam driven into the shale, then a tremie seal 9 ft. thick 20 ft. below lake level before attempting to dewater. Results of five test drillings to shale within the cofferdam area indicated conditions suitable for the use of sheetpiling instead of steel plate rings as caisson forms and the contractor elected to attempt this procedure. The cofferdam was easily dewatered and comparatively dry working conditions maintained. However, obstructions which were not indicated by the borings developed close to the shale surface and in the interest of time the whole substructure was redesigned for the use of steel 14-in. H-piles 102-lb. instead of concrete caissons. Tips were reinforced by two 11-in.-wide plates and four 6x4-in. angles welded on to reduce bearing on the shale to the assumed allowable of 2,300 lb. per sq. in. after driving to refusal.

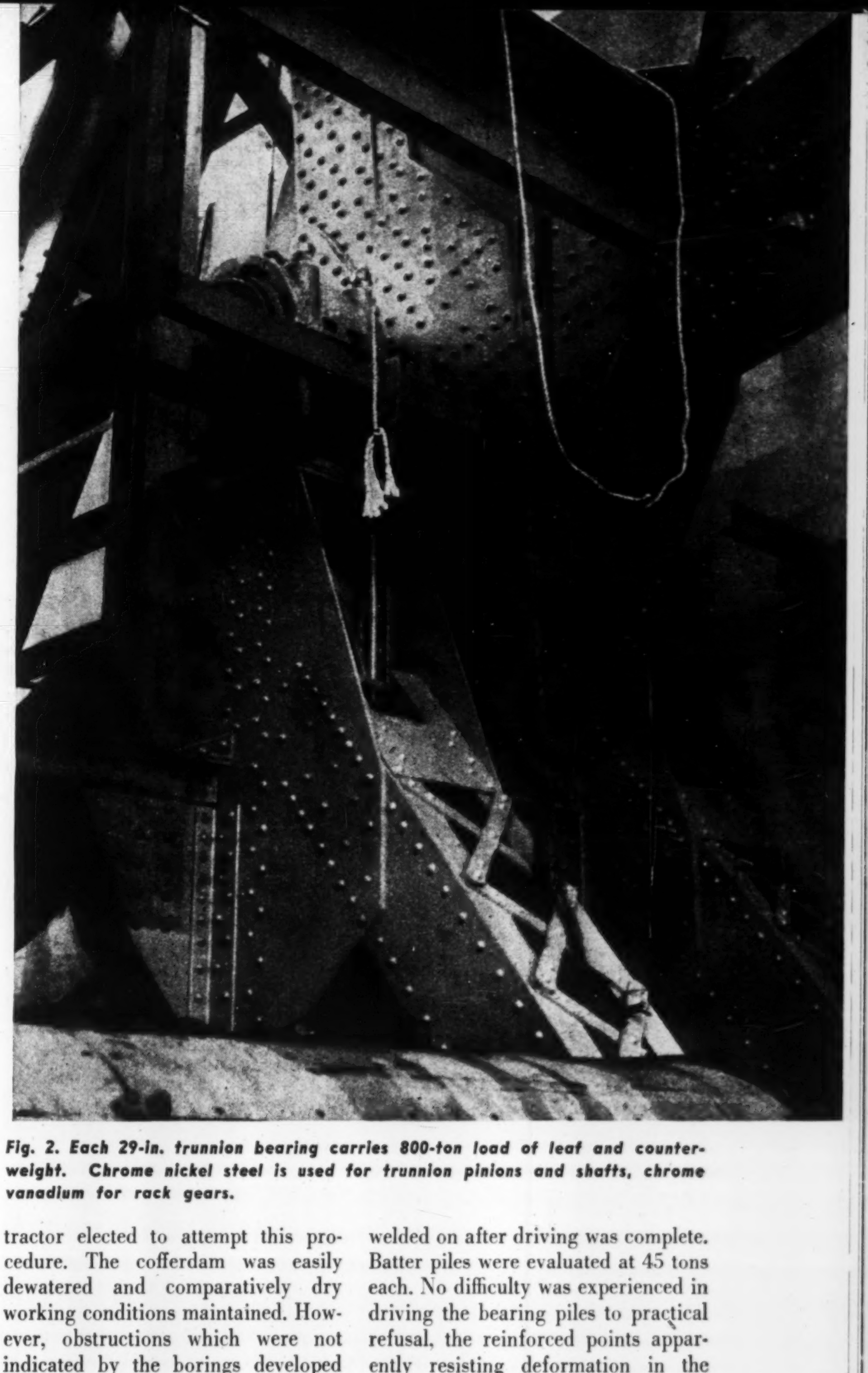


Fig. 2. Each 29-in. trunnion bearing carries 800-ton load of leaf and counterweight. Chrome nickel steel is used for trunnion pinions and shafts, chrome vanadium for rack gears.

Caps, designed to reduce concrete pressure to 830 lb. per sq. in., disregarding the bond on the pile, were welded on after driving was complete. Batter piles were evaluated at 45 tons each. No difficulty was experienced in driving the bearing piles to practical refusal, the reinforced points apparently resisting deformation in the material which turned the sheetpiling.

Construction procedure

Excavation and piledriving were done by floating derricks with the assistance of a land rig. Concrete was purchased delivered at the site by truck mixers, except the iron ore aggregate type which was mixed at the site in a 7S mixer, relatively small amounts being placed at a time to balance the erection of the bascule span.

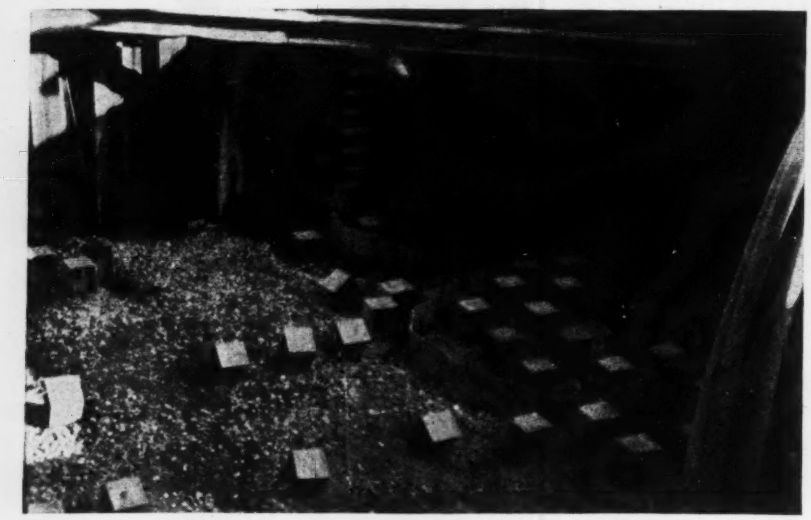


Fig. 3. H-beams driven to shale, and capped to distribute load on concrete support west pier after a circular sheetpile caisson scheme was abandoned.

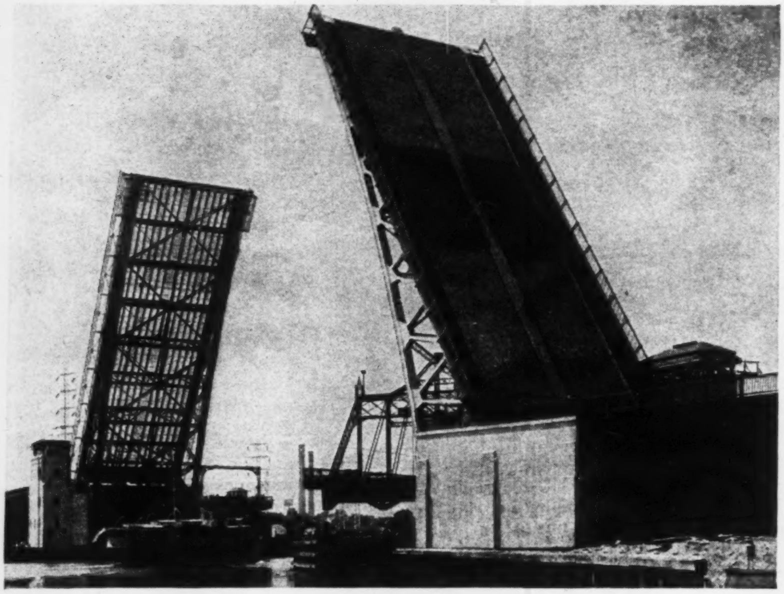


Fig. 4. How the long bascule with open-grid steel deck looked when completed. Old swing bridge adjacent is not being removed.

Superstructure erection, in open position to permit navigation, was done by long boom stiffleg erection derricks with one derrick set part way up on the open leaf to enable it to reach the 150-ft. height of the leaf. Fabricated steel members were delivered under the approach spans by rail, put on surface "dollys" and transported a few hundred feet to the westerly pier for erection or transfer to a barge which transported them across the channel to the easterly pier.

The bridge was financed by a Lorain County, Ohio, bond issue which included the construction of a 1,700-ft.-long high level bridge a short distance upstream. PWA assisted with a 45 per cent grant on both structures.

The bridge was designed and construction was supervised by Wilbur Watson and Associates, consulting engineers of Cleveland, for H. L. Dunham, county engineer of Lorain. Since the death of Mr. Watson in May, 1939, R. L. Harding has represented the Watson organization. For the county engineer, Walter W. Fleming, Harwood Lersch and Roger Hill were successive resident engineers, with G. D. McConnell, chief structural inspector.

The substructure was constructed by the Great Lakes Dredge and Dock Co. through their Cleveland Office. The Mt. Vernon Bridge and Iron Co. of Mt. Vernon, Ohio, fabricated and erected the steel and mechanical equipment. The Dingle Clark Co. furnished and erected the electrical equipment.

Garbage Handling Methods at Oak Park, Ill.

All combustible waste materials at Oak Park, Ill., are disposed of in the municipal garbage incinerator (including small dead animals such as cats and dogs), "without smoke, odor or nuisance of any kind," according to the annual report for 1939 of the Department of Public Works. The plant has a rated capacity of ten tons per hour. Garbage collection is handled by 18 men, with three 5-yd. motor trucks, five trailers, one tractor and three teams, working nine hours per day. Collections are made twice a week, except in bad weather. The incinerator is operated nine hours daily, except Sundays and holidays, and is open half a day on Saturday to receive commercial garbage. There are five men in all; two on the charging floor, one in the furnace room during the day and two at night to finish the burning and clean the furnaces and building. Men working on the collection and disposal forces work on a five-day week basis.

Collection of garbage and combustible waste by the Department aggregated 11,391.25 tons (including 644 small animals); in addition 2,164.75 tons were delivered at the incinerator by grocers, market men and others, making a total of 13,556 tons, with an average of 50.96 tons burned per day for 266 days. From the incinerator, 822.5 tons of ashes were taken to the dump. Cost of collection averaged $2.902 per ton, and disposal, 77.9c. per ton.

A combined collection of ashes, tin cans and other miscellaneous incombustible household waste was made about once a week. This material amounted to 70,320 cu. yd., or 10,177 loads, at a cost of 65.81c. per cu. yd. collected.

"Saddlebags" on Tractor Expedite Sludge Removal

SELECTING A METHOD of transporting sludge from the drying beds at the sewage treatment plant of the Aurora (Ill.) Sanitary District, was one of the problems considered when the construction of additional beds was undertaken in 1939. The original beds were served by cars on a narrow-gage track system, while a team and driver were hired occasionally to operate a scraper in leveling the sludge storage pile. However, it has been found difficult to hire teams from farmers just when they are needed. While different plans were under consideration, a suggestion was made by Walter Deutschler, engineer for the district, to use a sludge-carrying tractor with "saddlebag" bins, such a machine having been introduced at the plant of the Springfield (Ill.) Sanitary District a few years ago by W. B. Walraven, engineer of that plant.

Studies showed that tracks for the new beds at Aurora would cost some $3,000, while the tractor could be built for about $2,000, and would also be more economical in operation, due to reducing the labor force and eliminating the hire of teams. Beside reducing the cost of removing sludge, the tractor offered an important advantage in its availability for leveling and trimming the sludge storage pile, transporting grit, clearing snow from the driveways and doing other miscellaneous jobs.

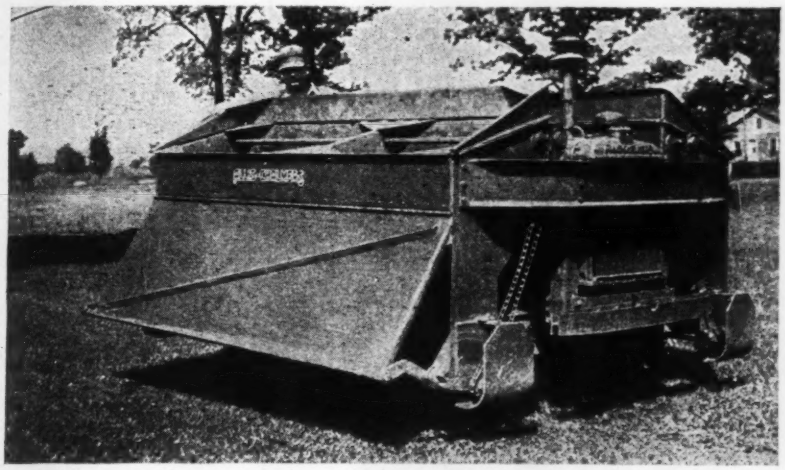


Fig. 1. Sludge-handling tractor with side bins of 3 cu. yd. capacity. The bins are opened by means of a hinge and lever arrangement to facilitate discharging.

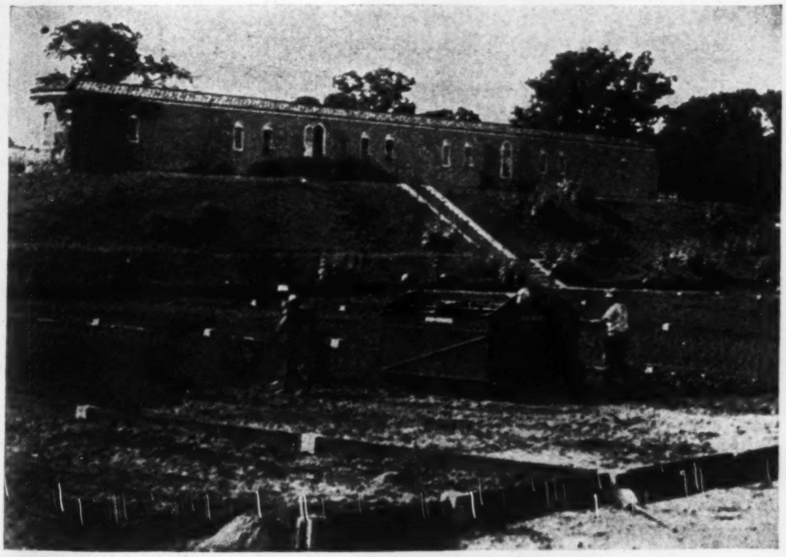


Fig. 2. The tractor at work on the sludge-drying beds at Aurora.

This sludge-handling tractor, which is practically a duplicate of the Springfield machine, consists of a standard machine, fitted with side bins having a capacity of 3 cu. yd. The bins are made with No. 8 gage sheet metal, and are designed for ready removal. In Fig. 1, the bins are shown open, or in discharging position; Fig. 2 shows the machine on the sludge beds. For use as a bulldozer in leveling storage piles and clearing snow, the bins are removed and a bucking board is attached. Both the machines mentioned were built at the Springfield (Ill.) plant of the Allis-Chalmers Manufacturing Co.

Performance details

Particulars of the new machine and its performance have been furnished by Walter A. Sperry, superintendent of the Aurora Sanitary District. In main overall dimensions it is 8 ft. long, 7 ft. wide, and 6 ft. high, to top of exhaust pipe. Its engine is rated at 32.4 hp, and gives four forward speeds of 2½ to 6 mph, as well as one reverse speed of 2½ mph. In weight, the tractor alone tops 6,500 lb., and with the bins adding 1,500 lb. the weight on the beds is 8,000 lb. As the bearing surface of the crawlers is 1,353 sq. in., the bearing pressure on the sludge beds, with bins empty, is 5.9 lb. per sq. in. With the bins full, the pressure is from 7½ to 9 lb. per sq. in., depending upon the moisture content of the sludge.

Up to Sept. 1, 1940, the tractor had been used for two complete cleanings of the ten sludge beds, each clean-up averaging 500 cu. yd., with a removal cost of $72 for extra hired labor, or 14.5c. per cu. yd. This may be compared with eight cleanings in 1939, averaging 390 cu. yd., with a cost of $189 each, or 48.6c. per cu. yd. With the tractor, only four men are hired at $15 per day. With the car and track method, seven men were hired along with a team costing $10 per day, making the expense $35 per day. Thus the machine is proving very satisfactory as to cost of sludge removal.

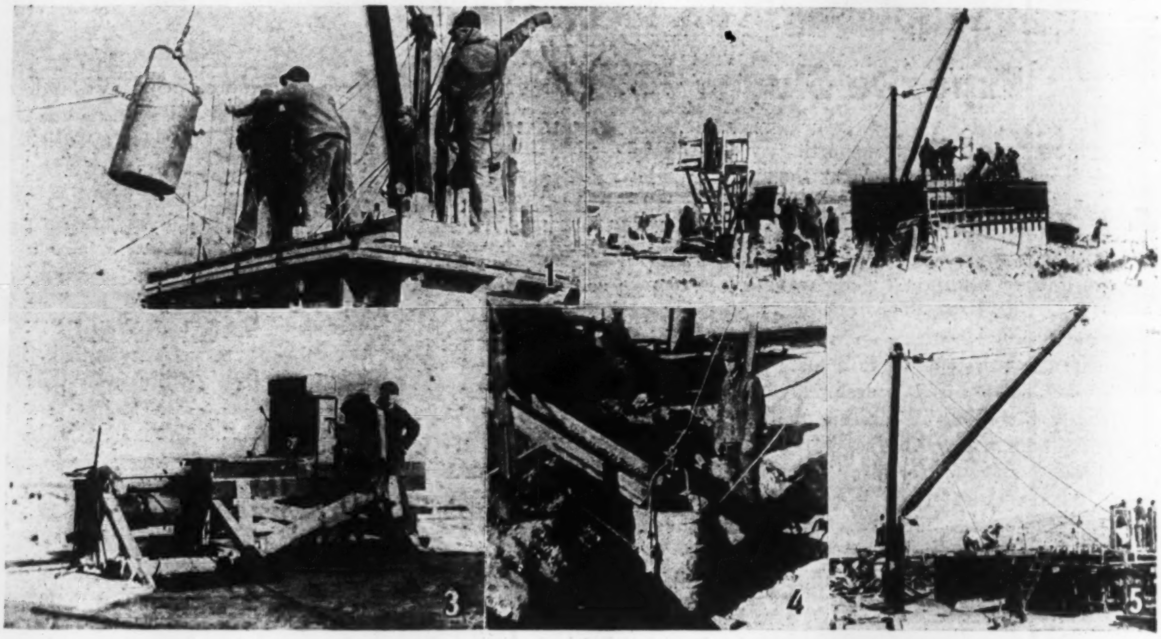


Fig. 1. Some of the job-made equipment used in concreting the Imhoff tank caisson.

Caisson Sinking with Job-Made Tools

R. F. Mirick
Killdeer, N. D.

Contents in Brief—*Ingenuity in assembling home-made equipment permitted sinking a 10x20-ft. caisson for an Imhoff tank for the Killdeer sewage plant without excessive expense. Bentonite was injected into the ground to aid in sealing the caisson after it was sunk.*

SKILL IN MECHANIZING the work from material at hand lends interest to the operation of sinking a small concrete caisson for sewage works at Killdeer, N. D. The caisson was of concrete, 10x20 ft. inside, designed to be used as an Imhoff tank. The site is quicksand to a depth of some 25 ft. at which is a layer of mixed sand and clay in which it was planned to bottom the caisson and which it was expected would be tight and strong enough to seal the bottom and hold out the water. The sand-clay stratum proved unable to take the hydraulic load and had to be handled as described later, but the first task in mechanization was in sinking the caisson.

The sewage works construction was a WPA operation and hand methods were of course at a premium. To handle materials into and excavation from the caisson, a derrick was made of electric light poles for mast and boom, Fig. 1 (5). The joint at the base of the boom was made from two old automobile drive shafts. Two short plates were welded to one shaft, and a 1-in. hole was drilled through the plates for a clevis. An eye was forged in the end of the other shaft, which was placed between the clevis plates, forming a flexible joint. Holes were bored in the base of the boom and in the stub pole into which the automobile shaft clevis worked. Flat iron plates placed over the shafts next to the clevis and eye kept the shafts from working too deep into the timbers. When the hole in the stub pole wore, it was bushed with a piece of iron pipe, and in that way was made to last to the end of the job. The boom was swung by a pull rope attached to its outer end.

The bucket used with this derrick was made from an old 50-gal. oil drum, hinged to swing as shown by Fig. 1 (1 and 4) and would handle one-bag batches of concrete very nicely. Fig. 1 (2) shows a general view of the job during a pour. Owing to cold weather, a small vertical boiler was used to heat water; one barrel in the tower contained water heated by the boiler, and another barrel arranged to provide gravity flow to the mixer tank was used to mix hot and cold water so that a supply not hotter than 150 deg. F. was available for the mixer. The man on the tower hoisted water with a bucket on a rope and mixed it to keep a supply at proper temperature. The man in the pit, Fig. 1 (4) attended to loading the bucket and firing boiler.

The power plant used with this derrick outfit, Fig. 1 (3), was made from the winch of a farm well auger machine and the motor from an old truck; the motor had a double set of transmission gears. A safety feature was a ratchet lever, shown sticking up from left end of the drum, that would engage and lock the gears. There was also a friction drum, operated by a hand lever, whereby the operator could hold the load line in any position. This outfit was calculated to be amply safe with a load of 1,000 lb. on the line. It worked admirably for a period of over three months.

Righting and sealing caisson

In seating and sealing the caisson the first step was to jet down wellpoints about 10 to 20 ft. apart, Fig. 2 (2). This illustration also shows how the 28-ft.-deep caisson had settled unevenly. Water pressure for the jet was supplied by the self-contained pump unit. The size of the wellpoints was 2 in.; these consisted simply of iron pipe with the lower edge serrated by sawing slits with a hacksaw and bending sections out to form teeth. The jet tool consisted of a $\frac{3}{4}$-in. pipe, longer than the 2-in. pipe, with a chisel-shaped tool welded in the bottom in such a way that water could spurt out each side of the chisel; in hard clay layers it was necessary to revolve the 2-in. pipe under weight, but elsewhere the jet alone was sufficient to sink the well pipe.

When a well had been jetted down to about 5 ft. lower than the tank walls a slurry of No. 35 bentonite was mixed. The bentoniting machine, as it was called, consisted of a 250-gal. tank; a double-cylinder double-acting pump, Fig. 2 (4 and 5), and a 4-cylinder 12-hp motor, all mounted on a truck. The speed of the motor, and hence the pump, could be varied at will. Pressure at times ran to as high as 45 lb. per sq. in. when forcing bentonite down the wells.

Valves and piping were so arranged that the pump could be used to lift water into tank, then circulate the water through the tank while bentonite was being stirred in with a wooden paddle. As soon as the slurry reached the desired consistency the valves were changed and the mix was forced into the ground. In all, about 14 tons of bentonite was used on the job. Bentonite was pumped into each well in several lifts; the pipe was raised a little between each lift, to be sure the bentonite was placed through a considerable layer of the sand. Pumping was continued until bentonite was seen coming up in some other place than the well being pumped, or else was seen coming into the pit surrounding the tank.

To right the tilted caisson, Fig. 2 (2) heavy steel beams were placed across the lower end of the tank and the reinforcing rods were then clamped to these beams, which were supported at the outer ends, and so the low end of the tank was kept from sinking farther. Then an old crawler tractor that had plenty of vibration about it, was driven onto the high end of tank and used as a vibrator to help settle the tank while men worked and dug inside after the water had been pumped down.

The bottom of the tank walls was resting in a sand-clay layer, which, while quite solid in itself, did not have enough strength to resist the hydraulic head of 23 to 25 ft. on the outside of the tank. The water would break through in spite of all that could be done; 2-in. sheetpiling was driven

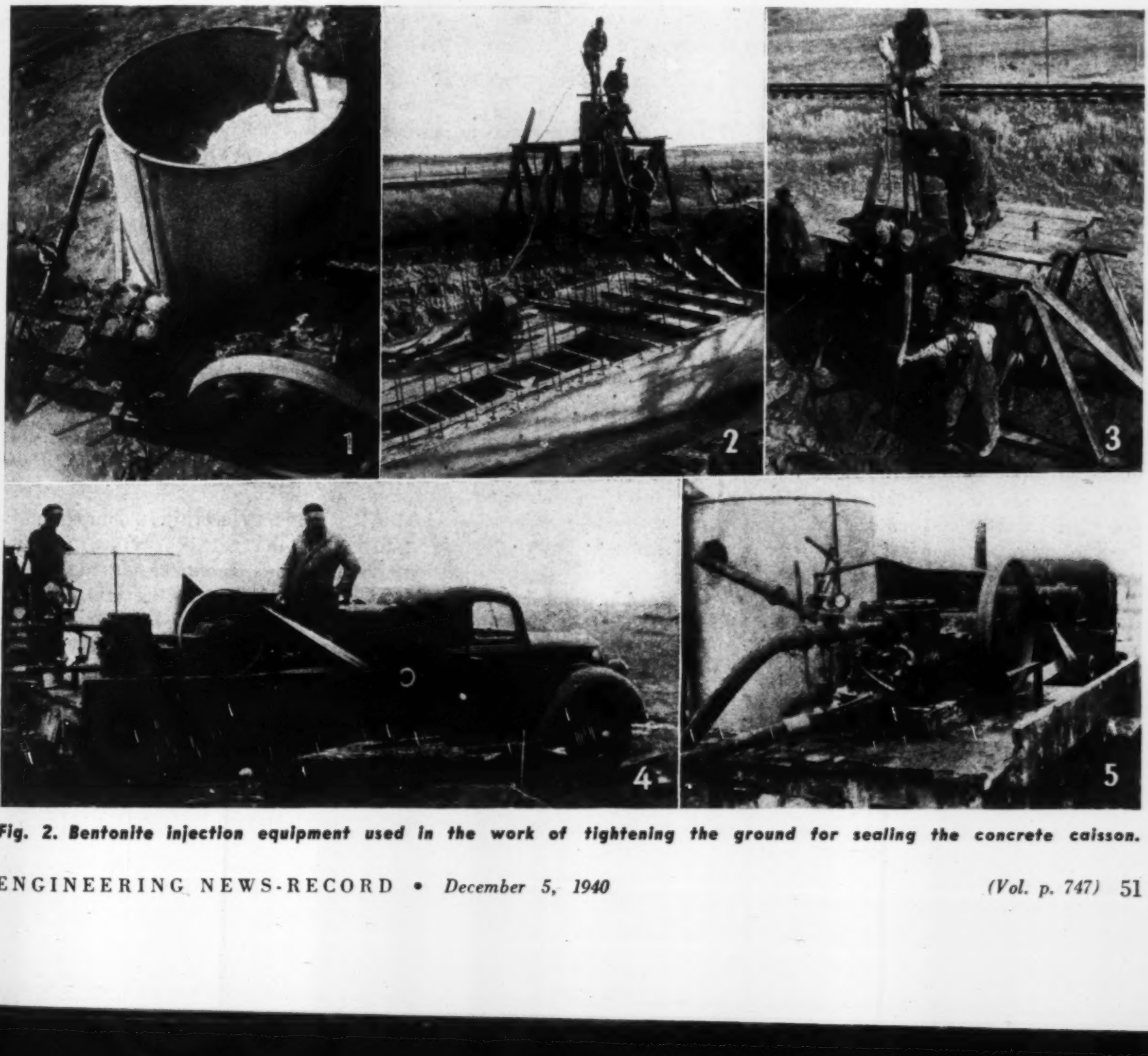


Fig. 2. Bentonite injection equipment used in the work of tightening the ground for sealing the concrete caisson.

down all around inside the tank to at least 10 ft. below the tank walls, but still the sand and water would ooze in. It had been hoped that the bentonite would clog up the interstices in the sand, but these hopes were only about 60 per cent realized.

The bentonite, applied as it was, slowed down infiltration so that it was possible to place sandbags and gravel and then place horizontal steel; then the tank was refilled with water hurriedly pumped in from the creek, so as to prevent too much infiltration of quicksand through the sandbags and gravel. A floor was poured through a tremie. When the tank was pumped down after the floor had been poured, there were a few slight seeps; these closed up soon, and it was assumed that the bentonite scattered around through the sand had something to do with the closure.

The WPA engineers were headed up by T. G. Plomasen and L. H. Belk, of the division of operations, Bismarck, N. D. R. J. Dingle was district engineer and E. B. Hall area engineer. The author, serving as supervisor, was in charge of the Killdeer project.

Concrete Cinder Block Cost Studies

R. A. Rothschild and W. D. Crawford

Alabama Highway Department, Montgomery

COST STUDIES in the production of 4x8x16-in. cinder blocks for the inside partitions of two new $500,000 Alabama state buildings indicate that the blocks could be made for $80 a thousand. The two buildings are the State Highway Department Building and the State Archives Building. The highway building has been completed for about three years and the Archives Building was finished this summer. As these buildings were WPA projects, it was desired to utilize a maximum of unskilled labor throughout. For this reason cinder blocks made on the job were used instead of structural tile.

Construction plant for making the blocks consists of a hand-powered block machine, a small concrete mixer and miscellaneous screens, shovels, etc. The mix used in the blocks includes the following proportions: one sack portland cement; 1½ cu.ft. sand; 4 cu.ft. cinders; 4 gal. of water. One such batch produces 18½ blocks. The cinders are crushed by hand and passed through a half-inch screen. The block-making machine is arranged to make numerous sizes with little adjustment. In addition, it leaves holes in the block, for the purpose of saving weight and material.

The blocks are of a light gray color, and are porous and rough-textured enough to have excellent heat and sound insulating qualities. The 4x8x16-in. block weighs about 23 lb. In using the hand-powered block-making machine the pressure applied to the material varies considerably from one operation to the next, and consequently the weight and strength of the block is not very uniform. Crushing strength over the 4x16-in. surface of the block, including the holes, which are perpendicular to this face, varies from 300 to 600 lb. per sq.in., averaging about 400.

A careful cost study has been made of the blocks manufactured for the Archives Building and is set out below. These costs were taken for the first 12,500 blocks and converted to give the cost of 200,000, the number required for the job.

Labor—A crew of a foreman and about ten laborers was found efficient. One man loads and operates the mixer, three men operate the block machine, one man is kept busy stacking the previous day's run, and four or five men crush and screen cinders. Carpenters' time for building a shelter shed for the block machines is also included. For 200,000 blocks the labor cost is:

Carpenters, 76 man hours at 75¢	$ 57.00
Foremen, 2,840 man hours at 47¢	1,334.80
Labor, 22,800 man hours at 28¢	6,384.00
Total labor	$7,775.80

Equipment—The largest item of equipment is the block-making machine and its cost will vary with the size of the job. The machine used for the Highway Department Building made about 200,000 blocks, and a ready sale was found for it at half price. One open shed is needed to house the machine, and it should be large enough to store a day's run of block, as these must be protected for 24 hours.

An old concrete mixer was bought and used in making block for the Archives Building, so this item may be somewhat smaller than normal. It may be pointed out, however, that the machine is not given very severe service, and that minor breakdowns are not costly nor even very inconvenient, as the men can always be kept busy crushing cinders. Equipment costs for 200,000 blocks are:

Block machine, half of $940.00 (cost)	$470.00
Concrete mixer, half of $50.00 (cost)	25.00
Old lumber for sheds, concrete for crushing mat, etc. (allow.)	75.00
Misc., screens, shovels, etc.	100.00
Total equipment	$670.00

Material—Cinders for both of the jobs referred to were donated by the local railroads, and no public agency should have difficulty in obtaining them. The cost of crushing was included in the labor above, and included here is 10¢ per yard for hauling. A wide range of sand may be used but it should be fairly carefully graded. Good results are obtained with a mortar sand ranging from 16 to 100 mesh. Materials costs are:

2,700 bbl. portland cement at $2.48	$6,696.00
600 cu.yd. sand at $1.15	690.00
1,600 cu.yd. cinders at 10¢	160.00
Total material cost	$7,546.00

The total cost may then be summarized:

Labor	$7,775.80	48.6%
Material	7,546.00	47.2
Equipment	670.00	4.2
Total	$15,991.80	100%

In most localities a comparison will show that this cost of nearly $80 per thousand is somewhat higher than for 4-in. clay tile. Certain other considerations must be taken into account. It has been found that the block can be laid up somewhat faster than tile, affording some economy of skilled labor. Plaster grounds can be put up more readily as they can be nailed directly into the block with plain wire nails. Walls are also likely to be straighter.

Z-Pile Wall Driven Under Traffic

G. M. Zucco
Structural Engineer
Bethlehem Steel Co., Seattle, Wash.

AN IMPORTANT PART of the modernization of the famous Pike Place Market in Seattle was the replacing of a wood retaining wall built in 1906 and repaired a number of times in its more than thirty years of service. Because of the hilly contour of this part of the city, the height of the retaining wall averages about 20 ft. with a maximum height of 32 ft. At the foot of the retaining wall, only a few feet away, is a row of commercial buildings, warehouses and similar structures, the first two or three stories of which face the wall, while the higher stories extend above it in unobstructed view of the market.

Over a period of years studies have been made of means of replacing the existing wall. All solutions suggested included a counterforted wall which would have required digging out practically the entire street, thus closing the market for three months.

Development of Z-type sheetpiling finally permitted a design with a cost nearly 40 per cent lower than the counterforted wall and made continuous access to the market possible during construction. As shown in Fig. 1, the steel piling is supported at the top by an economical combination of coping and wale tied back to a deadman. ZP 32 piling was used on a maximum 23-ft. unsupported length, and ZP 38 piling on a 30-ft. span. Piling was driven about 9 ft. below the lower ground elevation into a very stiff blue clay. Steel rods up to 2⅝ in., with upset ends, were used at 10½-ft. centers to tie back the tops of the sheeting. Piling was driven just inside the old wall, the street being broken up only in the immediate vicinity of the work. Cuts for placing the deadmen and ties were made at night and, when necessary, temporary covers were used to maintain traffic during business hours.

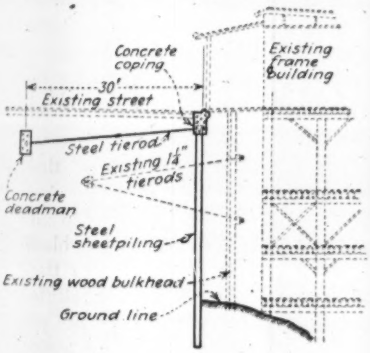


Fig. 1. Section through Z-pile retaining wall. Maximum span from ground to tierod is 30 ft.

The design and construction were under the direction of C. L. Wartelle city engineer, and was supervised by Oscar A. Piper. The Western Construction Co., Inc., Seattle, were the contractors, and the piledriving was sublet to Manson Construction & Engineering Co., Seattle.

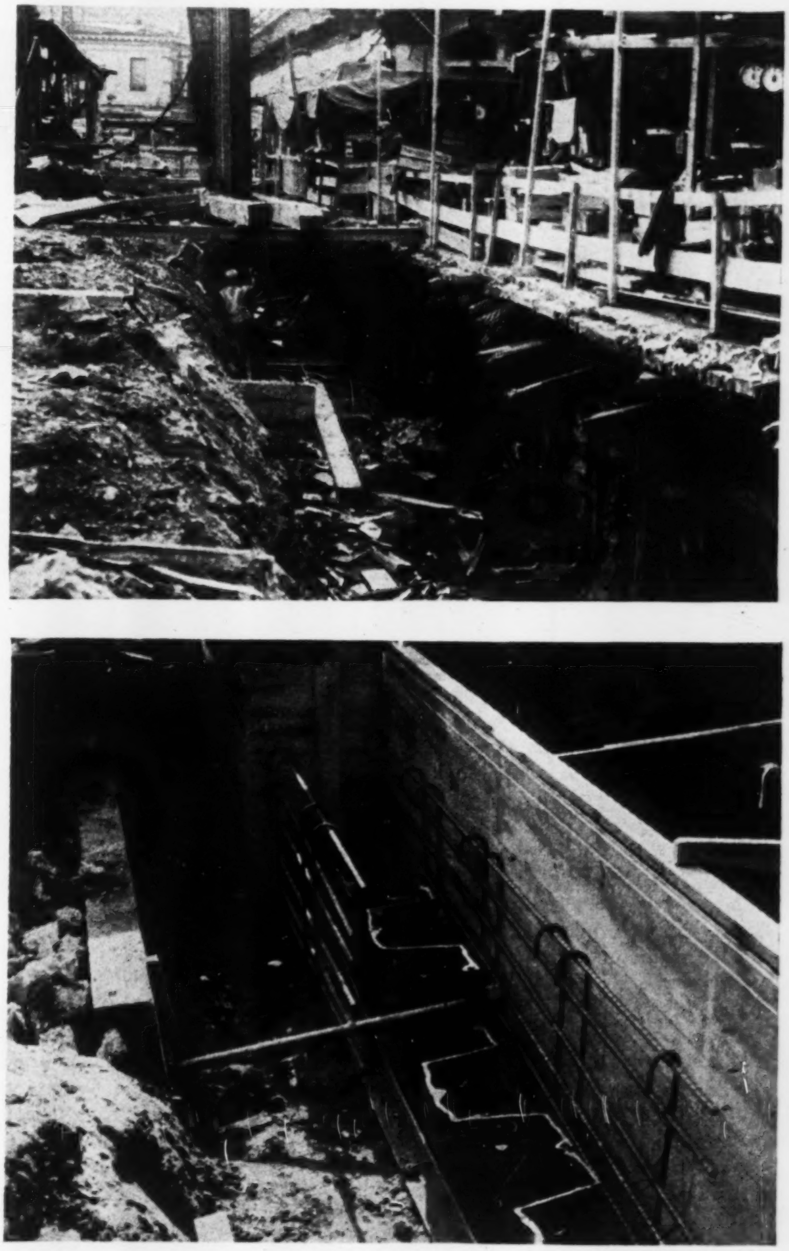
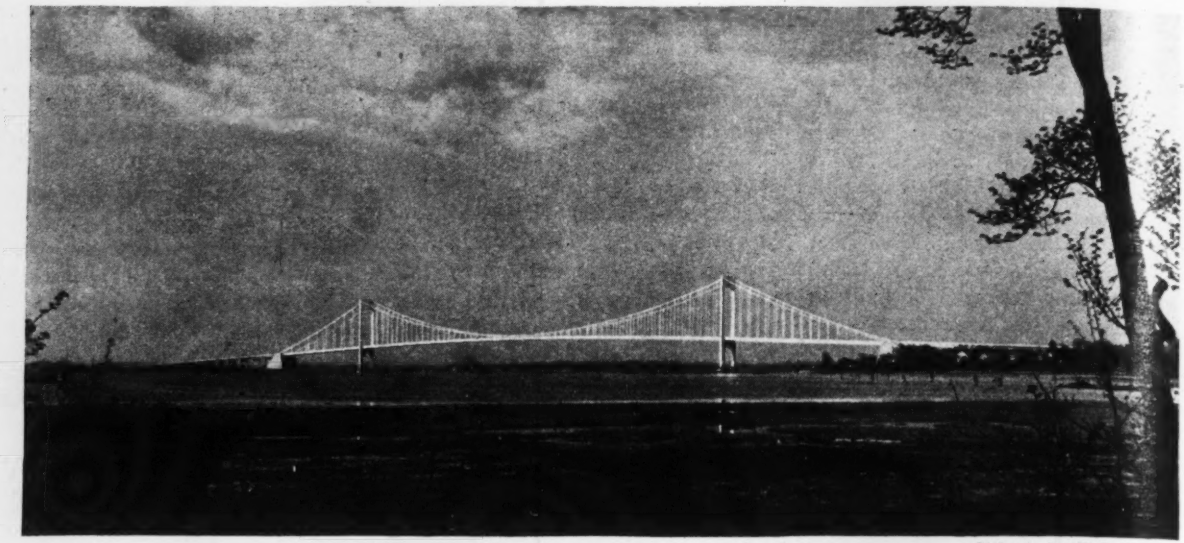


Fig. 2. Old wood retaining wall. New sheetpile wall being driven in background at top. Bottom: Concrete coping reinforced to serve as wale. Note piling left high to serve as washer for tierod.



Richard Averill Smith photo

Whitestone Bridge has been carrying heavy traffic between Queens and Bronx boroughs for more than a year and a half.

Stays and Brakes Check Oscillation Of Whitestone Bridge

Contents in Brief*—Diagonal stay ropes are being installed on Whitestone Bridge to check vertical oscillation, supplementing brakes and midspan guys in service from beginning. Model tests verified the efficiency of the damping devices.*

UNDER A CONTRACT just concluded, diagonal stay ropes extending from the tower tops to the deck are being installed on Whitestone Bridge, New York, to complete a system of damping devices to check vertical movements of the suspended structure.

Small oscillations of the bridge had been noticed during construction, and initial stabilizing equipment was therefore installed before the bridge was opened to traffic. The diagonal stays were adopted as a supplementary device after elaborate tests on a model conducted at Princeton University by Prof. E. K. Timby for the Triborough Bridge Authority. The tests showed that such stays will check oscillations effectively; of several alternative arrangements of stays the adopted one was concluded to be best.

The complete Whitestone Bridge stabilizing installation as supplemented by these stays is shown in the adjoining drawing. It comprises a set of short diagonal guys at midspan connecting the cables with the stiffening girders, a powerful brake at each tower to restrain endwise movement of the suspended structure, and the diagonal stays, of which there is a set in the main span and one stay each in the side spans. The guys and brakes have been in service from the beginning in temporary form, but have been rebuilt and improved in the 1½ years since the opening of the bridge (April 30, 1939).

Experience at Whitestone

Whitestone Bridge, which crosses the East River between Queens and Bronx boroughs, New York City, has a main span of 2,300 ft. and two side spans of 735 ft. each, carrying a suspended deck 74 ft. wide, the cable spacing also being 74 ft. The stiffening members are 11-ft. plate girders, continuous between the towers. It was the first long-span bridge to be built with plate-girder stiffening members of relatively shallow depth. The 3,500-ft. George Washington Bridge, which in its present state has no longitudinal stiffening members, is rendered relatively stable by its great weight, while in the lighter Whitestone Bridge this factor is not as potent. However, Whitestone is much more massive and rigid than the recently destroyed Tacoma Narrows Bridge; its deck is twice as heavy, its stiffening girders are four times as rigid and its lateral system nearly twice as wide and ten times as rigid, according to O. H. Ammann, chief engineer of the Triborough Bridge Authority during construction of the Whitestone Bridge.

Oscillation was first noticed in Whitestone Bridge while the floor reinforcing grid, with form plates for the floor slab attached, was being erected. The motion was observed in winds blowing at an angle to the bridge axis, and was accompanied by longitudinal swinging of the deck. The combined movement was attributed to pendulum action, possibly caused by the longitudinal component of wind pressure acting against the lower surface of the cambered deck. However, upward currents at openings in the floor showed that strong vertical wind forces also were present.

It was decided to restrain the pendulum action by buffer blocks between deck and towers and diagonal guys from cables to stiffening girders at midspan. A temporary installation of such devices was made before the bridge was opened to traffic, and as they had a favorable effect but proved to be too weak they were replaced a few months later by heavier guys and friction brakes.

Marked improvement in the action of the bridge was observed, but the restraining devices still showed evidence of being overtaxed. Brakes and guys were therefore redesigned for larger forces, with details carefully worked out to develop full efficiency. The midspan guys, each a 1⅞-in. wire rope, were made adjustable for stretch by providing for the insertion of shims back of the socket attachments to the lower pins. The brakes were designed for a friction force of 180,000 lb., developed by a steel friction tongue 12x2½ in. sliding between bearing blocks held down by a weight acting on a multiplying lever system. The lever multiplication is 38, and as the weight can be increased to 12,000 lb., a bearing pressure of 450,000 lb. can be developed, to provide the desired resistance with a friction factor of 0.20.

These devices, installed during the past summer, are shown in the drawing. They have reduced the oscillation to negligible amount.

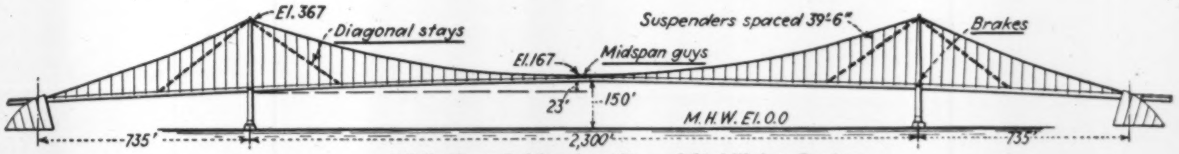
Observations on bridge and model

Early in 1940 systematic measurements of the movements of the bridge were begun, using a transit mounted at the tower to observe targets attached to the bridge at the quarter points. Previous knowledge was limited to the fact that persons on the bridge felt discomfort in certain winds. The instrumental observations prior to installation of the final brakes and guys showed vertical oscillation reaching a maximum of 14 in. up and down or 9 in. in one direction, with a period of 5 to 6 sec. No lateral movement and no tilt or twist were observed at any time.

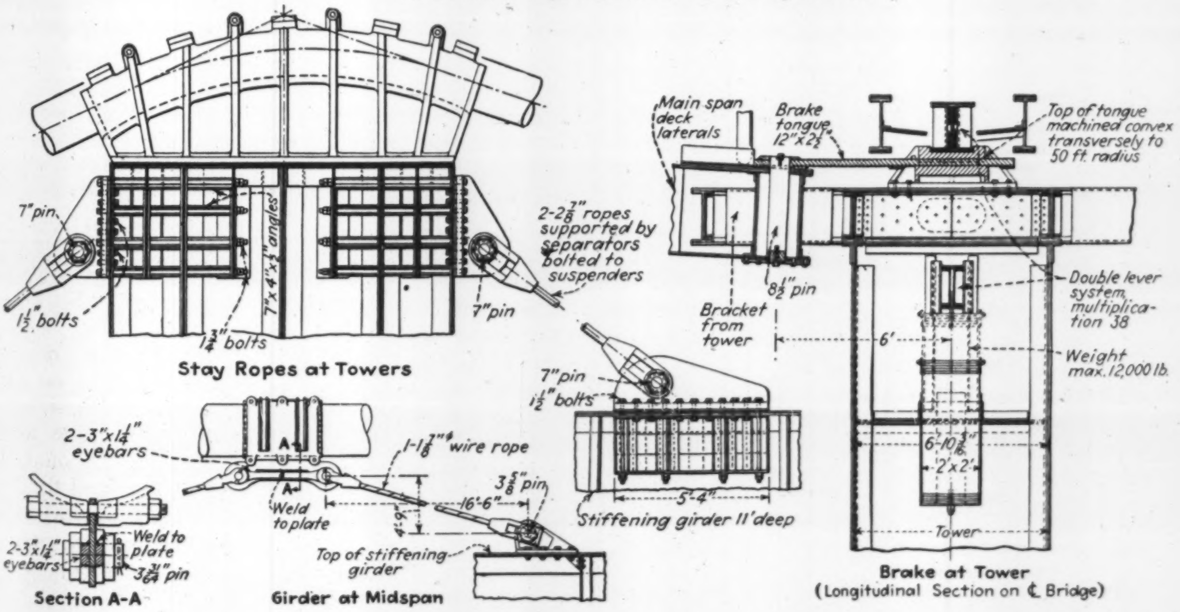
The most common motion was an oscillation having a node at midspan, one-half of the suspended structure bowing up while the other bowed down, and vice versa. Sometimes the motion showed two nodes in the main span (three oscillating segments), and still more rarely the vibration was without node, the full length of the main span oscillating as one segment.

To parallel the field observations it was decided to test an elastic model of the bridge as a means of determining the quantitative effect of the devices already installed and working out means of providing additional damping, if this should be found desirable. The model was built to a scale of 1:100, with sectional areas, masses and rigidities in true proportion, to duplicate the elastic behavior of the bridge. For convenience a single cable was used in the model, this being sufficient to reproduce motions in the vertical plane. However, lateral effects on the deck could also be measured, since the rigidity of the deck was in true proportion to that of the bridge.

The actual forces that set up motions of the bridge could not be reproduced, as they were unknown. Therefore the model was actuated by attaching loads at the panel points and suddenly releasing them. Various loadings corresponding to maximum deflection of the bridge were


El. 367
Diagonal stays
Suspenders spaced 39'-6"
Brakes
El. 167
Midspan guys
23'
150'
M.H.W. El. 0.0
735'
2,300'
735'

Whitestone Bridge-Location of Stabilizing Devices


7" pin
1½" bolts
1¾" bolts
7"x4"x½" angles
2-2⅞" ropes supported by separators bolted to suspenders
7" pin
7" pin
1½" bolts
5'-4"
Stiffening girder 11' deep
2-3"x1¼" eyebars
A
A
Weld to plate
1-1⅞"ϕ wire rope
3⅝" pin
16'-6"
4'-9"
Top of stiffening girder
2-3"x1¼" eyebars
Weld to plate
3$\frac{31}{64}$" pin
Main span deck laterals
Brake tongue 12"x2½"
Top of tongue machined convex transversely to 50 ft. radius
8½" pin
Bracket from tower
6'
Double lever system, multiplication 38
Weight max. 12,000 lb.
6'-10$\frac{3}{16}$"
2'x2'
Tower

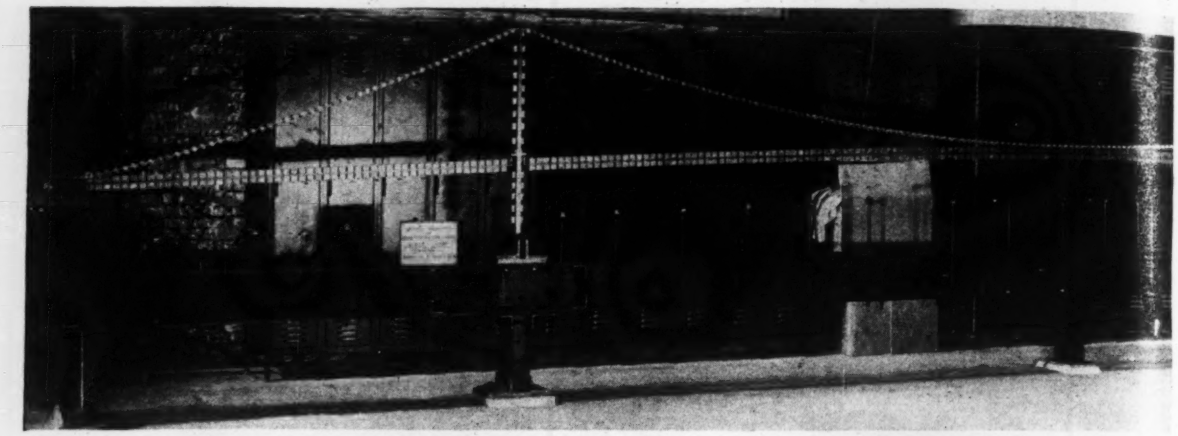
Stay Ropes at Towers

Section A-A

Girder at Midspan

Brake at Tower
(Longitudinal Section on ℄ Bridge)

Location and arrangement of brakes and stays on Whitestone Bridge. The diagonal stays from tower tops to deck are now being installed, after tests on an elastic model showed their efficacy.



Development of damping devices for Whitestone Bridge has been carried out by aid of a 1:100 elastic model at Princeton.

applied, to produce representative oscillations.

Model test findings

It was found that the model developed motions precisely like those of the bridge. It had oscillations with no node in the main span, a node at midspan, two nodes, and sometimes three nodes. The time of oscillation checked closely with that of the bridge, namely, 5 to 6 sec.

Friction brakes corresponding in efficiency to those shown in the drawing (not yet installed at the time of test) proved to reduce the oscillations materially. Both longitudinal and vertical oscillations damped out much more rapidly with brakes applied than with brakes off.

Different arrangements of diagonal ties between towers and stiffening girders were tried: one, two and three diagonals per tower in the main span alone or combined with one or two ropes in the side spans. Under certain loads several diagonals had more effect than a single diagonal, but when all methods of loading were considered the conclusion was that a single diagonal from each tower in both main span and side span was most effective.

The latter arrangement was adopted. In the subsequent detail design two $2\frac{7}{8}$-in. wire ropes were used in each diagonal, as shown. The installation was recently placed under contract.

Effect on bridge

Marked decrease of oscillation of the bridge had followed the early installations of brakes and midspan guys. The final installation during the past summer further improved the control, and since that time the vertical oscillations have amounted to only a few inches. As no feelings of discomfort have been reported, the structure is believed to be satisfactorily stabilized. Addition of the diagonal stays will provide a further reserve of stability.

Summarizing the record of study and control of movements of the Whitestone Bridge, Mr. Ammann says: "We have had to deal with very small movements, and would have felt no concern about them had they not tended to produce discomfort in some persons under unfavorable conditions. No question of the safety of the bridge is involved. Its width, weight and the shortness of its side spans assure it of adequate rigidity for all conditions. To remove all possibility of discomfort or feeling of insecurity on the part of passengers, however, we believed that the restraining and damping devices should be provided to limit the natural elastic movement to an amount that would be imperceptible."

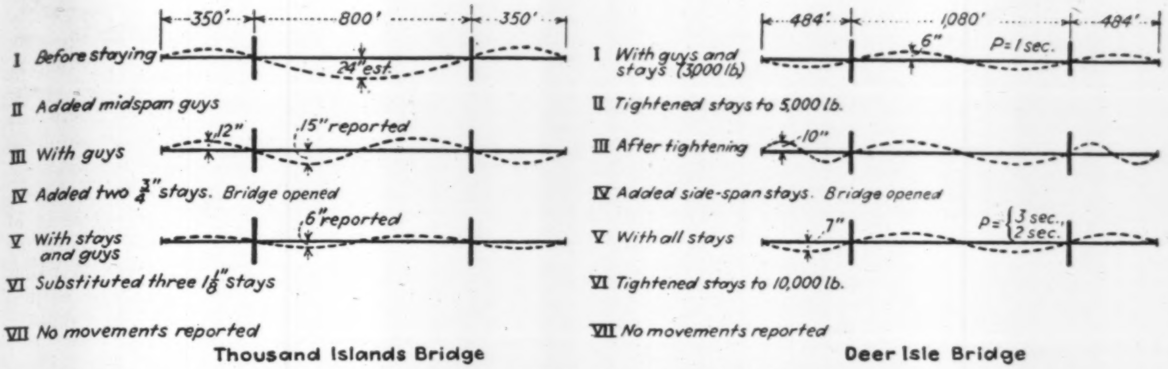
Two Recent Bridges Stabilized by Cable Stays

OCCURRENCE of disturbing vertical movements or undulations in suspension bridges of slender proportions antedated the recent experiences at Whitestone and Tacoma by more than a year. At both the Thousand Islands Bridge over the St. Lawrence River in New York and the Deer Isle Bridge in Maine, marked undulation was observed when the bridges neared completion. The engineers for the Thousand Islands Bridge, Robinson & Steinman, developed a successful control system consisting of diagonal rope stays from roadway level at the towers to the cables of the main span, and a year later, in June, 1939, applied the same system, with the addition of similar stay cables in the side spans, to the Deer Isle Bridge. In both cases the undesirable undulation has been brought under complete control.

The following data on the observed undulation and the development of the control stays is taken from Robinson & Steinman's records.

Stabilizing Thousand Islands

Two suspension spans form the principal elements of the two-lane highway bridge across the St. Lawrence. The American crossing has a main span of 800 ft. and two 350-ft. side spans, with deck width and cable spacing of 30 ft. 6 in. The clear height at midspan is 150 ft., and because of the requirements of the profile the floor is heavily cambered, the roadway being 15 ft. higher at midspan than at the towers. The Canadian crossing is somewhat smaller, the main span being 750 ft. and the side spans 300 ft., while the height is lower, midspan clearance being 120 ft. The stiffening members of


350'
800'
350'
I Before staying
24" est.
II Added midspan guys
12"
15" reported
III With guys
IV Added two ¾" stays. Bridge opened
6" reported
V With stays and guys
VI Substituted three 1⅛" stays
VII No movements reported
484'
1,080'
484'
I With guys and stays (3,000 lb.)
6"
P = 1 sec.
II Tightened stays to 5,000 lb.
III After tightening
10"
IV Added side-span stays. Bridge opened
V With all stays
7"
P = 3 sec., 2 sec.
VI Tightened stays to 10,000 lb.
VII No movements reported

Thousand Islands Bridge

Deer Isle Bridge

Fig. 1. Observed movements and effect of stabilizing devices on Thousand Islands and Deer Isle suspension bridges.

both crossings are plate girders 6 ft. deep, the deck weight 2,850 lb. and the total dead weight 3,200 lb. per lin. ft. The following remarks apply to the American crossing, which was the site of the main observations and development.

Undulatory movement was first noticed in June, 1938, when the framework of the suspended structure was complete and the I-Beam-Lok grid of the floor slab, with attached steel form plates, was being put down. It was then thought that the addition of the floor concrete would steady the bridge, but this proved not to be the case. The motions were most marked in a quartering wind, even if only a moderate breeze. As observed specifically on July 12, 1938, the main span moved up while the side spans moved down, in a period of about 4 sec.; this undulation was accompanied by longitudinal swinging of the main span, plainly apparent at the short suspenders near midspan.

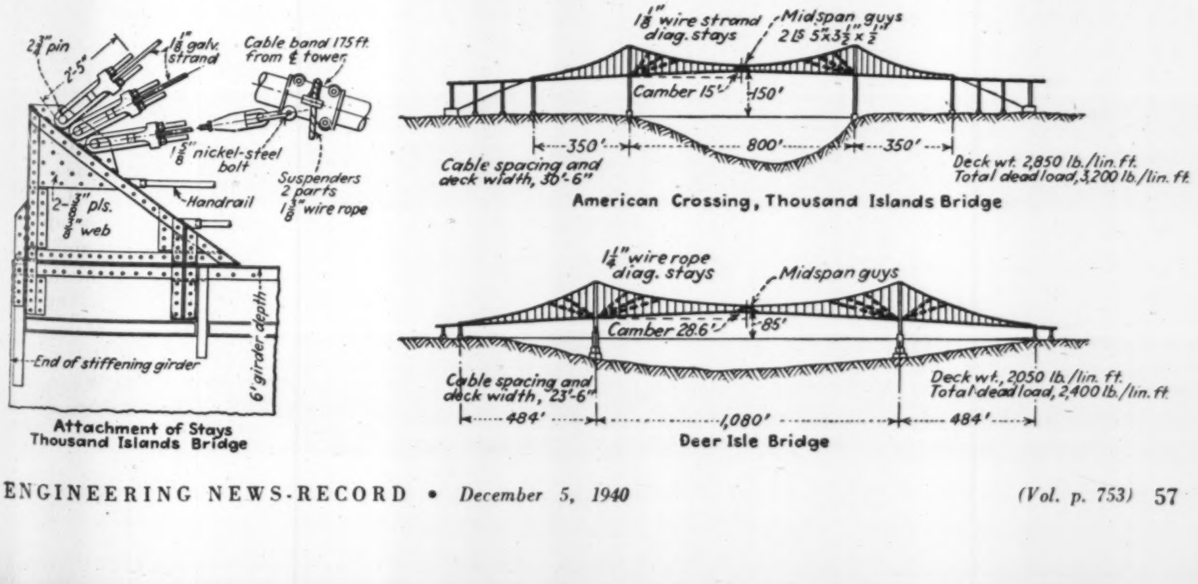
The first effort at control consisted of installing temporary wire-rope diagonal guys between the central cable band and the adjacent suspender connections at the top of the stiffening girder. These ties eliminated the longitudinal swing of the span and reduced the undulation, changing it into a motion with node at center—one quarter point of the span going up while the other quarter point went down. While previously the maximum vertical movement had been estimated at more than 24 in., the movement after addition of the temporary ties was reported as 15 in. in the main span and 12 in. in the side spans. The prior tendency of the girders to get out of step and warp the floor seemed to have disappeared.

For further control various methods of diagonal bracing by stay ropes were studied, with the conclusion that a set of stays anchored to the ends of the stiffening girders and fanning out to connect with cable bands on the main span cables was best. This system was the only one that promised to hold its tension under temperature changes. In consequence a temporary stay system of this type was installed, two days before the formal opening and dedication of the structure (Aug. 18, 1938).

The stays comprised two diagonals at each corner of the main span, each consisting of two parts of $\frac{3}{4}$-in. steel hoist rope with steamboat ratchet for adjustment. They ran to the fourth and sixth cable bands, and were pulled up to about 5,000 lb. tension.

After the opening of the bridge certain winds still caused motion, the amplitude now being about 6 in. The permanent installation was therefore designed with three stays instead of two, connected to the third, fifth and seventh cable ends, each placed under 10,000 lb. tension (or with vertical sag of 3, 7 and 13 in. respectively). Each stay was made of a 1⅛-in. prestressed galvanized strand pinned to the stiffening girder and a cable band

Fig. 2. Stabilizing installations on Thousand Islands and Deer Isle suspension bridges. The long diagonal stays extending upward to the cables are 1⅛ and 1¼-in. wire ropes; the short diagonals at midspan are pairs of angles bolted to the middle cable band and riveted to the top flange of the stiffening girder. The Deer Isle Bridge, which is longer and narrower than Thousand Islands and has greater camber, required stays in the side spans as well as the main span.


2¾" pin
2'-5"
1⅛" galv. strand
Cable band 175 ft. from ℄ tower
1⅝" nickel-steel bolt
Suspenders 2 parts 1⅜" wire rope
2-⅝" pls.
⅜" web
Handrail
End of stiffening girder
6' girder depth
1⅛" wire strand diag. stays
Midspan guys 2 ∟s 5"×3½"×½"
Camber 15'
150'
350'
800'
350'
Cable spacing and deck width, 30'-6"
Deck wt. 2,850 lb./lin. ft.
Total dead load, 3,200 lb./lin. ft.
1¼" wire rope diag. stays
Midspan guys
Camber 28.6'
85'
Cable spacing and deck width, 23'-6"
Deck wt., 2,050 lb./lin. ft.
Total dead load, 2,400 lb./lin. ft.
484'
1,080'
484'

Attachment of Stays
Thousand Islands Bridge

American Crossing, Thousand Islands Bridge

Deer Isle Bridge

bolt as shown. The required strand tension was determined by live-loading tests on a model. At the time the stays were installed, the temporary tie cables at the center of the span were replaced by double-angle struts.

Since this installation (Jan. 24, 1939) there has been no report of undulation, and it is believed that if any oscillatory movements remain they are imperceptible.

The Canadian crossing, probably because of its shorter span and more sheltered location, showed much less pronounced movements. The same system of diagonal stays and mid-span struts was installed here, and no report of disturbing oscillations has been received.

Deer Isle Bridge installation

While the Thousand Islands problem was being worked out in the field, construction of another suspension bridge of slender proportions was under way at Deer Isle, Me., under the same engineers. Since it had longer span, narrower deck and greater camber than the former structure, it was expected to develop oscillation, and stays similar to those at Thousand Islands had been designed for it. In fact, the initial set was in place, though not yet adjusted, when oscillation was first observed.

Late in May, 1939, when the concrete roadway slab was about half laid, a strong east wind set up vertical oscillation of about 6 in. at the quarter points of the main span. Diagonal stays were in place in the main span only, in addition to mid-span ties. Three weeks later, after preliminary tightening of the stays (to half the final tension), the roadway slab being completed, marked oscillation developed in the Deer Isle side span, with amplitudes up to 10 in.; the main span, however, was steady and there was no noticeable movement of the tower top. Temporary stays were placed in the side spans for the formal opening of the bridge (June 19, 1939).

During the next few weeks undulation occurred repeatedly. Thus, on one day the Sedgwick side span got into motion under a "slight northerly breeze", with a period of 3 sec. and a (measured) amplitude of 7 in. The whole side span oscillated as one segment, while on a previous occasion it had oscillated with a node in the middle. On another day the main span undulated more than the side spans, "really too much for the average motorist", according to the resident engineer's report.

In August permanent stays were placed in the side spans, but the main-span stays, which had been fabricated too long for adjustment to the desired tension, had not yet been resocketed and tightened. Under these conditions oscillations with a period of 3 sec. were observed, and a day later a period of 2 sec. was noted.

Resocketing was done soon afterward, and the 1¼-in. wire rope stays, each supported at mid-length, were tightened to sags corresponding to 10,000 lb. tension. This final operation was fully effective. There has been no perceptible oscillation of the bridge in 15 months of service.

Patent has been granted Robinson & Steinman on the arrangement of diagonal stays from the ends of the stiffening girder or truss to points of the cable for checking vertical undulation of a suspension bridge.

Measuring Flow in Open Channels

H. G. Wilm
Rocky Mountain Forest and Range Experiment Station
Fort Collins, Colo.

IN MEASURING DISCHARGE of small streams and open channels it is frequently desirable to gage small volumes of flow containing some bed-load, silt and trash. For this purpose, the standard current-meters and pitot tubes are often unsatisfactory because of the shallow depths, debris, or other reasons. As a practical substitute for these measuring devices, the rod shown in the accompanying view has been developed.

In principle the instrument resembles a pitot tube in its direct measurement of depth (pressure) and velocity-head; in method of use it is similar to the Clausen-Pierce "Weir Rule" (See "Hydraulic Measuring Stick," *Western Construction News*, Aug. 25, 1929, p. 424). It consists simply of a 1x3-in. staff of strong wood and convenient length. After one edge is beveled from both sides with the bevel beginning two inches from the sharp edge, a sheathing of thin copper is applied over this edge and the foot of the rod shod with a brass plate. The calibrations, in feet and tenths, are then shown by bands painted completely around the rod.

In using the instrument water depths are measured in four or more locations across the stream by immersing the rod with its sharp edge facing upstream. For a second set of readings, the rod is reversed so that its one-inch face is turned directly upstream, which produces a small hydraulic jump. The average height of this jump above the streambed measures the specific energy of flow at that point of measurement. After the depth or first reading has been subtracted, the net height of the jump measures the actual velocity-head at that point. The velocity is then computed by the standard formula:

$V = \sqrt{2gh}$ in which V is the velocity in feet per second, g acceleration due to gravity, and h the velocity head. The average error of this instrument, based on 37 measurements checked against calibrated weirs and flumes, is about ± 1.64 per cent.

Limitations of the rod include inaccuracy for velocities much below one foot per second and in streams with soft, unstable beds. Neither can it be handled well in large, deep streams, or with velocities greater than 8 or 10 fps. It has a practical application within its range of use.

Although simple to construct, rod measures velocity in small streams within two per cent.

New Highway on Old Railway

Geo. H. Tuttle
Highway Engineer, Littleton, N. H.

MAKING A HIGHWAY of an old railway is one of the interesting road-building jobs that the New Hampshire state highway department has under way. The railway being transformed takes one back to an older day of transport in the White Mountains summer resort business. Referring to the map Fig. 2 for locale: In 1878 the Profile R.R. Co. built a narrow-gage branch line from the Boston & Maine R.R. to the Profile House near Echo Lake, a distance of about 9 miles. At this time both the Profile House and the Flume House were doing a good summer tourist business, and this railroad service was a welcome substitute for a long dusty ride behind the four- and six-horse coaches that had served the public up to this time.

In 1915 the old narrow-gage track was replaced with a standard-gage track and at this time a wrought iron trestle, 288 ft. long and 65 ft. above Lafayette Brook, was built to take the place of the old wooden trestle which was not strong enough for the heavier equipment. About this time the Flume House burned and was not rebuilt. In 1923 the Profile House burned, so the railroad was definitely deprived of a purpose. It was then discontinued and the rails removed; now only a brush-choked grade and the trestle remain except for short sections that have been cleared for local logging operations.

Several years ago a far-sighted engineer of the state highway department persuaded the state to purchase this abandoned roadbed with the idea that it would some day prove of great value as a relocation for the present narrow winding road with its steep grades. Although preliminary surveys were made, no construction was started until the spring of 1939, when W. H. Hinman, Inc., of Maine was the low bidder for a section 1.5 miles long, extending from Gale River to the next intersection of the railroad with the existing highway, at a cost of about $67,000.

The typical section (Fig. 1) called for a 24-ft. surface treatment on a 4-in. crushed stone surface laid on an 18-in. gravel base, with 12-in. gravel shoulders. As the railroad was a single track with numerous curves, the cuts and fills had to be widened to conform with modern standards of highway construction. Most of the old culverts were stone boxes and were replaced with either reinforced concrete pipe or reinforced concrete boxes.

The preliminary plans for the next section of this project call for about 5.5 miles of construction along the old railroad grade, beginning opposite the Aerial Tramway and connecting with the 1939 section mentioned above.

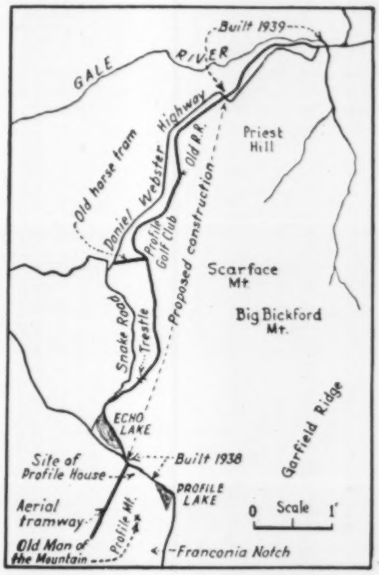


Fig. 2. Revamped railway provides a better automobile route to the scenic heart of New Hampshire's famous White Mountains.

The purpose of the relocation is to replace a section of the Daniel Webster Highway, which has so many sharp curves and grades that part of it is locally known as the "Snake Road."

F. E. Everett, state highway commissioner; D. H. Dickinson, chief engineer; and J. O. Morton, construction engineer, will have immediate supervision over construction. The widening of the existing Lafayette Trestle will be under the supervision of J. W. Childs, bridge engineer.

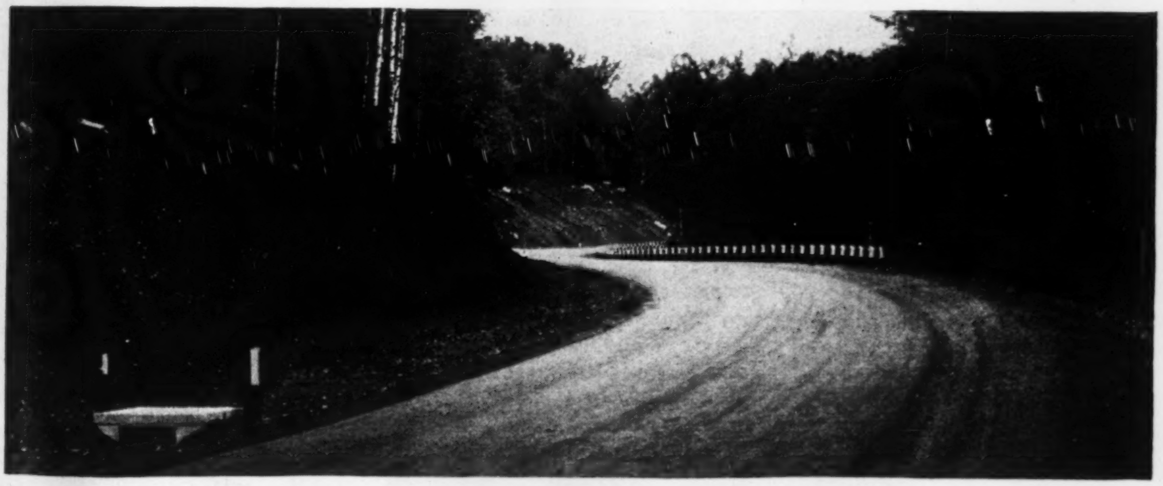


Fig. 1. A modern highway for which New Hampshire is utilizing an old railway grade.

A Non-Distorting Soil Sampler

F. B. Slichter

Engineer, Missouri River Division
U. S. Engineer Department, Kansas City, Mo.

DISTORTION OF THE SPECIMEN is the common fault of soil sampling. For his shear or consolidation test the laboratory worker wants an undisturbed soil. In the true sense of the word, "undisturbed" of course defines a soil sample that is recovered without changing the original orientation of the soil particles or the pore water pressures therein. Recovery of a completely undisturbed soil sample is an impossibility, but reduction to a minimum of those factors which cause disturbance during sampling has been obtained with apparatus developed recently by the Missouri River Division of the U. S. Engineer Department.

In investigating the failure of Marshall Creek Dam, during the fall of 1937, so-called undisturbed samples were taken with a sampler fitted with a 6-in. cutting shoe and barrel. The sampler was driven by the blows of a 700-lb. stem acting through a set of drilling jars and operated by the walking beam of a drill rig. All samples except those from strata of fat clay were visibly disturbed. In Fig. 1 a half-section of a sample taken with this apparatus shows how the originally horizontal soil layers were badly folded and the soil at the top of the sample was dragged down along the outside.

To obtain samples for the re-design of the dam, a sampler illustrated by Fig. 2A, was designed to minimize disturbances in the soil samples. Vibration was eliminated by a double-acting hydraulic jack which is forced through its 28-in. stroke in from 1½ to 3 min. The arrangement of the operating mechanisms is indicated diagrammatically in Fig. 2B. Under operations to date the apparatus has been used to depths of 63 ft. The total drive loads required in sampling have been as follows:

Soil Penetrated	Tons
Wet shale (form. Pennsylvania series)	30
Medium sand (damp)	24
Medium sand (dry)*	
Silty loam (compacted roll fill)	11
Medium clay (saturated)	8
Silty clay loam (saturated)	3

*Refused penetration under 35 tons, the maximum capacity of the oil pump.

In addition to driving and retrieving the soil sampler, the jack is used in driving and pulling the 8-in. casing which is added in lengths of 56 in. Connections for attaching the jack to the sampler and to the casing are indicated in Figs. 2C and 2D. A 28-in. removable extension to the base of the jack permits two 28-in. samples to be taken before a length of casing is added.

Recently, improvements have been made in the design of the sampler. The sampler used at Marshall Creek is illustrated in Fig. 2E. It is of the Casagrande-Mohr type and recovers a 5 27/32-in.-diameter sample in a 28-gage oiled blue steel liner. Ports are provided in the shoe and head of the barrel where either vacuum or air pressure can be introduced. Provision is made for the use of a wire cutter in the shoe, but in soils sampled to date the friction in the shoe has been sufficient to break off the sample as the sampler was withdrawn. The use of this sampler with 8-in. casing requires an intermediate clean-out operation between consecutive sample drives.

To eliminate this extra operation, a sampler with sufficient space in the head for accumulating the clean-cut from a 7-in. casing is shown by Fig. 2F. Another improvement is the inclusion of a valve in the head of the sampler which will be kept closed by a light spring. By introducing air under pressure through a port in the head of the barrel, water will be prevented from entering the sampler as it is dropped into the casing. As the soil enters the sampler, the air will be discharged through the valve which will open under the increase in air pressure. Upon withdrawal of the sampler, a vacuum will be introduced into the barrel through the port in the head. With this sampler a cycle of operations will consist of only two steps: driving the sampler, and driving the casing.

The various features of the apparatus have been included in a patent application by the writer and R. N. Platts, associate engineer, P. T. Bennett, assistant engineer, and E. L. O'Donnell, principal engineering aide, who co-operated in the development under the direction of Col. C. L. Sturdevant, Division Engineer, Missouri River Division, U. S. Engineer Department.

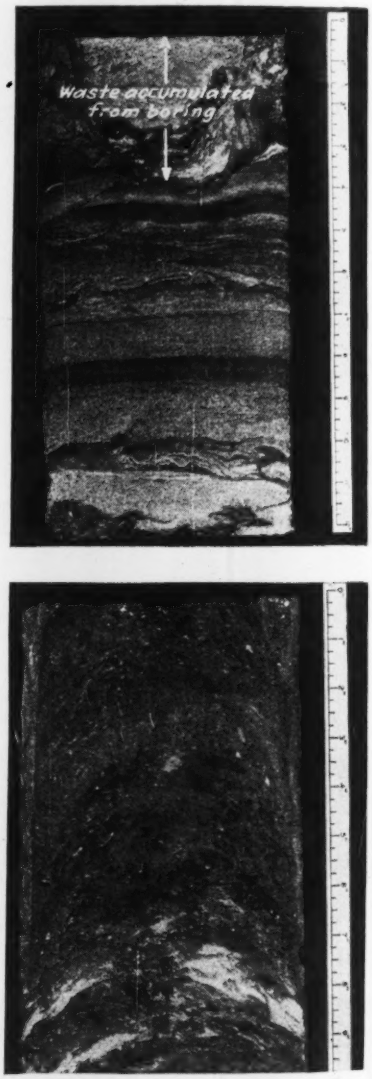
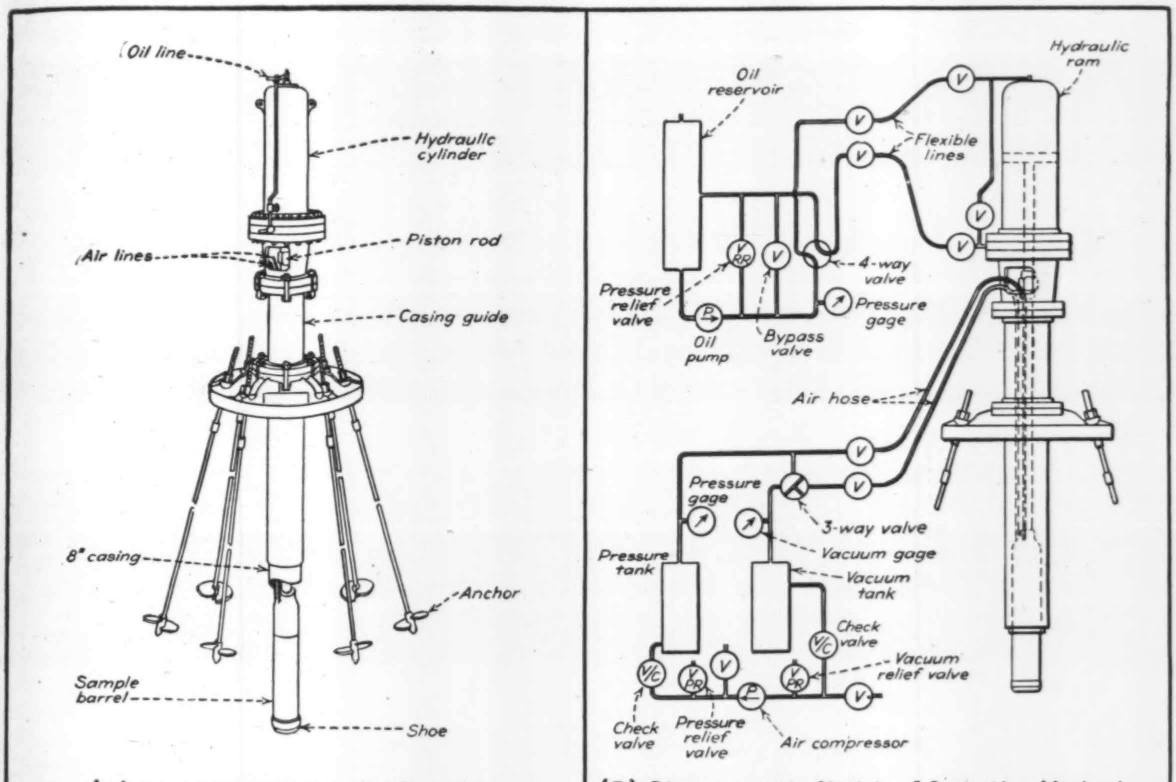
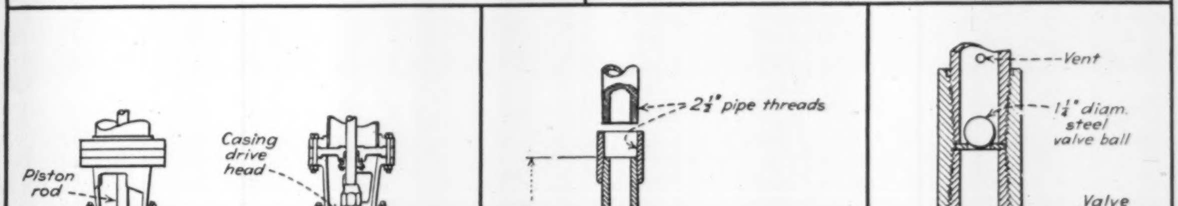


Fig. 1. How an undistorted sample taken by jack-driven sampler (top) compares with a sample taken by a sampler driven by hammer blows.


Oil line
Hydraulic cylinder
Piston rod
Air lines
Casing guide
8" casing
Anchor
Sample barrel
Shoe
Hydraulic ram
Oil reservoir
Flexible lines
V
V
RR
4-way valve
Pressure relief valve
Pressure gage
P
Oil pump
Bypass valve
Air hose
Pressure gage
3-way valve
Vacuum gage
Pressure tank
Vacuum tank
Check valve
V/C
PR
Vacuum relief valve
P
Check valve
Pressure relief valve
Air compressor

(A) Assembled Hydraulic Sampler

(B) Diagrammatic Sketch of Operating Mechanism


Piston rod
Casing drive head
Winged coupling
Piston rod extension
Casing coupling
Drive stem 2½" pipe
Casing guide
Casing
Sampler
2½" pipe threads
9"
Check valve ball type
4"
Air ports
7"
Sq. thd. 4/in.
28-gage oiled blue steel liner
wide grove around entire circumference
1"
2'-2"
6.063"
30°
45°
30°
Sq. thd. 4/in.
5
6⅞"
Cutter Detail
Sections
Vent
1¼" diam. steel valve ball
Valve cam
Air pressure
Valve
Pressure or vacuum port
Valve comp. spring
Clean-out storage
Sheet metal liner
Groove for cutting wire
Shoe

(C) Connections for Sampling

(D) Connections for Driving Casing

(E) Sampler Used at Marshall Creek

(F) Two-Cycle Sampler

Fig. 2. Details of the jack-operated soil sampler developed to reduce the disturbances to samples.

Concrete for the outlet portal is dumped to a conveyor which elevates it to the hopper of a concrete pump.

River Diversion at Green Mountain Dam

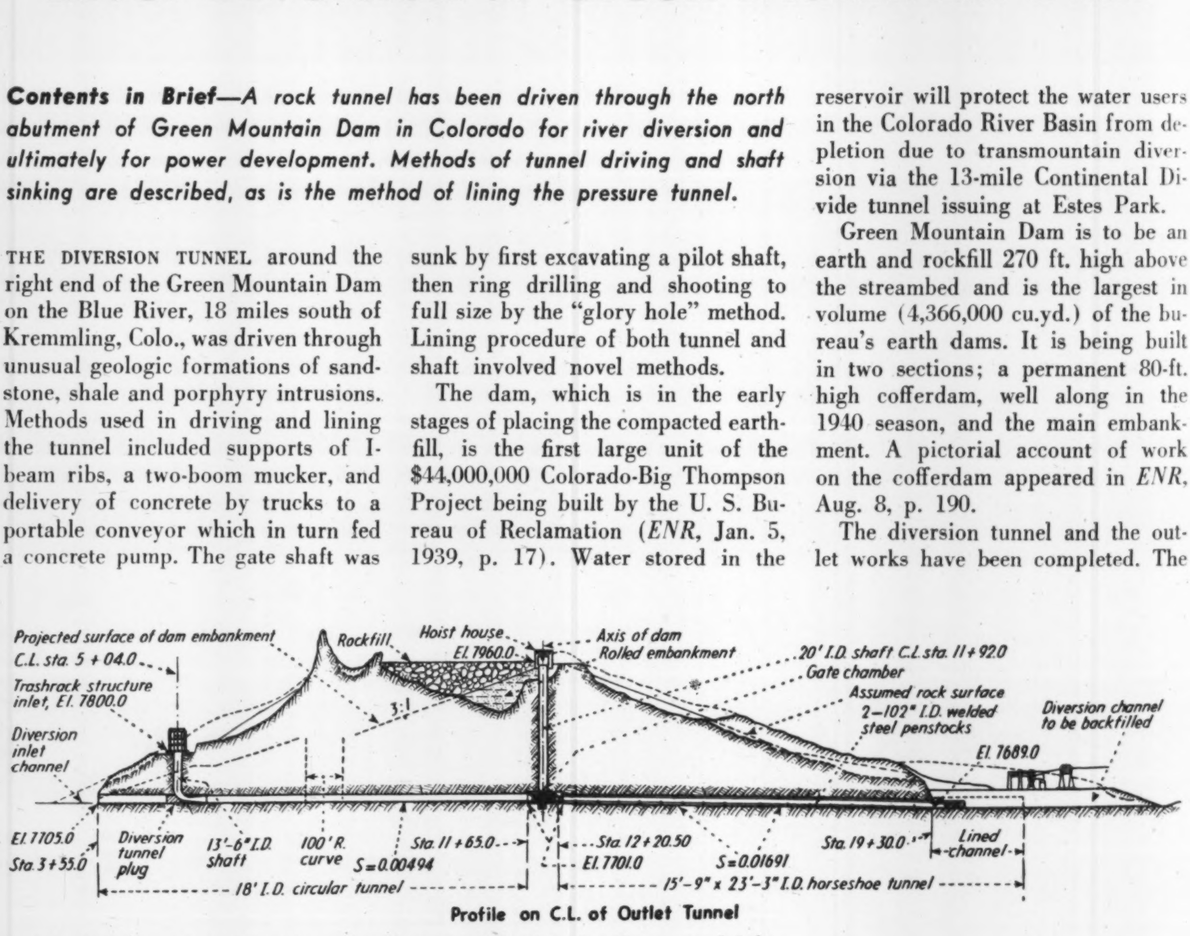
***Contents in Brief**—A rock tunnel has been driven through the north abutment of Green Mountain Dam in Colorado for river diversion and ultimately for power development. Methods of tunnel driving and shaft sinking are described, as is the method of lining the pressure tunnel.*

THE DIVERSION TUNNEL around the right end of the Green Mountain Dam on the Blue River, 18 miles south of Kremmling, Colo., was driven through unusual geologic formations of sandstone, shale and porphyry intrusions. Methods used in driving and lining the tunnel included supports of I-beam ribs, a two-boom mucker, and delivery of concrete by trucks to a portable conveyor which in turn fed a concrete pump. The gate shaft was sunk by first excavating a pilot shaft, then ring drilling and shooting to full size by the "glory hole" method. Lining procedure of both tunnel and shaft involved novel methods.

The dam, which is in the early stages of placing the compacted earthfill, is the first large unit of the $44,000,000 Colorado-Big Thompson Project being built by the U. S. Bureau of Reclamation (*ENR*, Jan. 5, 1939, p. 17). Water stored in the reservoir will protect the water users in the Colorado River Basin from depletion due to transmountain diversion via the 13-mile Continental Divide tunnel issuing at Estes Park.

Green Mountain Dam is to be an earth and rockfill 270 ft. high above the streambed and is the largest in volume (4,366,000 cu.yd.) of the bureau's earth dams. It is being built in two sections; a permanent 80-ft. high cofferdam, well along in the 1940 season, and the main embankment. A pictorial account of work on the cofferdam appeared in *ENR*, Aug. 8, p. 190.

The diversion tunnel and the outlet works have been completed. The


Projected surface of dam embankment
C.L. sta. 5 + 04.0
Trashrack structure inlet, El. 7800.0
Diversion inlet channel
Rockfill
Hoist house
El. 7960.0
Axis of dam
Rolled embankment
20' I.D. shaft C.L. sta. 11 + 92.0
Gate chamber
Assumed rock surface
2—102" I.D. welded steel penstocks
Diversion channel to be backfilled
El. 7689.0
3:1
El. 7705.0
Sta. 3 + 55.0
Diversion tunnel plug
13'-6" I.D. shaft
100' R. curve
S = 0.00494
Sta. 11 + 65.0
Sta. 12 + 20.50
El. 7701.0
S = 0.01691
Sta. 19 + 30.0
Lined channel
18' I.D. circular tunnel
15'-9" x 23'-3" I.D. horseshoe tunnel

Profile on C.L. of Outlet Tunnel

Profile of the tunnel used for river diversion and ultimately for the power intake.

tunnel is divided into three sections, a pressure tunnel, a gate section and a penstock section. The pressure tunnel is circular, 18 ft. in finished section and 823 ft. long ending at a 32x50-ft. gate chamber. The lower section is 650 ft. long, a modified horseshoe 15¾x23¼ ft. in form which will contain two 102-in. plate-steel penstocks. Connecting with the gate chamber is a 20-ft. circular shaft 240 ft. deep. After completion of the dam the upper 190 ft. of the upstream tunnel will be plugged; inlet to the tunnel will then be provided by a 15½-ft. circular inlet shaft 70 ft. deep. A trashrack structure over the inlet shaft will contain a floating bulkhead. In the gate chamber are to be located two 102-in. ring-seal gates.

The outlet channel below the diversion tunnel is through easily eroded material and is concrete-lined; after completion of the dam it will be backfilled. A diversion discharge of 10,000 cfs, twice that of record, is possible with 15 ft. of freeboard on the cofferdam.

Tunnel operations were started at the inlet end since at the lower end it was first necessary to remove 70,000 yd. of common excavation and an equal yardage of rock. Five months after excavations of the upstream portal started, the tunnel was holed through. Lining and placing of concrete in the shafts required about the same length of time.

Materials encountered in the main tunnel were porphyry and Morrison shale, the latter being on the bottom third with dip 6 per cent downstream. In the Morrison shale 30 per cent powder was used and in the porphyry 40 to 60 per cent powder. In all but 100 ft. of the tunnel, steel supports of 6-in. 12½-lb. I-beam ribs were required on 16 to 72-in. centers. Some 180,000 lb. of steel liner plates were used for ground support. In a few instances in bad ground liner plates were bolted to the I-beams.

Method of drilling

The type of drill round was a modified V-cut which was changed to suit rock conditions. From 44 to 52 holes were drilled per round in the upper tunnel and as many as 76 holes per round were necessary in the penstock section. Drilling was usually done in 8-ft. rounds from a rebuilt Metropolitan Water District drill carriage having four side-wing folding platforms operated by air jacks. This mounted jumbo moved over a track. Six automatic drifter drills were mounted in the circular section and eight in the modified horseshoe. These machines had a 4-ft. feed. Detachable side-hole bits were used with 4, 8 and 10-ft. steel.

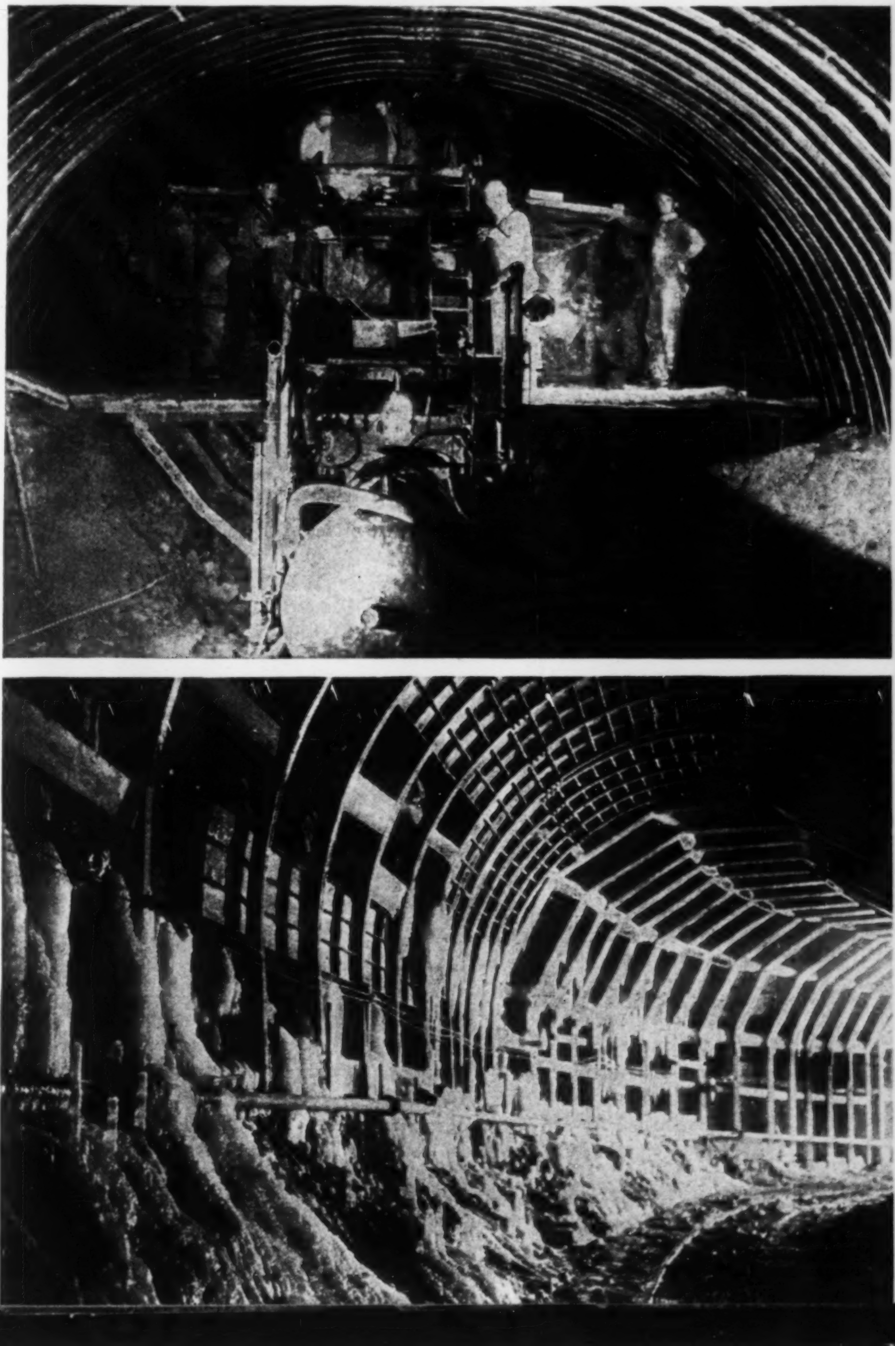
Air was supplied by five 445-cfm compressors driven by 75-hp motors and delivered to the heading through a 4-in. line. A tank carrying sufficient water to supply the drills for a full round was mounted on the drill carriage. Two 3,500-cu.ft. blowers furnished air for ventilation through two 20-in. fabric vent tubes discharging close to the face of the heading.

Muck was loaded into four 3-yd. diesel-powered trucks by a 50-hp, 3-drum electrically operated slusher scraper. This machine was mounted on a carriage operated on a narrow-gage track. The slusher carried two adjustable booms and its bottomless bucket was pulled up a ramp over the trucks by cables running through blocks on the two booms.

Sinking the gate shaft

Mining methods were used in sinking the 20-ft. gate shaft which is in porphyry for 150 ft. down. First an 8x8-ft. pilot shaft was sunk by con-

Drill jumbo with folding platforms and a water tank for drilling operations at top. Bottom: Winter conditions in the tunnel before it was lined. This shows the transition from timber roof supports to steel I-beam ribs and steel liner plates.



ventional method to intersect the tunnel at the gate chamber. As a matter of interest both pilot shaft and tunnel arrived at the intersecting point within 24 hr. of each other. A 36-in. chute gate was installed at the bottom of the pilot shaft and the shaft was enlarged from the top down by the "glory-hole" method, shaft muck being drawn off as necessary through the chute gate and hauled out by the diesel trucks when they were not employed in mucking operations at the heading.

Lining of the shaft with 18 to 30 in. of concrete, depending on the type of ground encountered, followed the excavation down in 10-ft. lifts. A gallows headframe over the shaft supported a receiving hopper which delivered the concrete to the forms through a spout that could be swung around in the shaft. Concrete was fed into the forms through openings 10 in. deep at the top and below the previous pour.

For sinking the 15½-ft. intake shaft the stoping method of excavation was used.

Handling concrete

A concrete plant was erected while the tunnel was being driven. It consisted of one sand and two gravel stockpiles on a level circular area at the foot of a steep hill. Aggregates were delivered by truck at the top of the hill and were sent down in stone ladders to prevent segregation. A stiff-leg derrick operating a 1-yd. clamshell bucket filled hoppers over the mixing plant which was located farther down the hillside. Weighing hoppers below the storage hoppers fed two 28-S non-tilt mixers set on the same level as the cement storage shed. Mixing for 1¾ min. was required. Concrete was hauled to point of placement in 1½-ton trucks.

Lining the tunnel started with the invert by deposition of concrete into guide forms set to line and grade on concrete anchor blocks at the contact between invert and arch. Where there was no reinforcing the trucks dumped the concrete near the final location from which it was shoveled into place, then vibrated and shaped by a hand-operated float. Where reinforcing bars precluded the entry of trucks, concrete was delivered to a portable belt conveyor discharging into a concrete pump for pumping into the forms. An air winch dragged a heavy template, 10 ft. long, over the newly placed concrete. After fine screeding with a light hand-operated template, finishers worked from a platform riding on the guide forms and under a tarpaulin to keep seepage water from dripping on the concrete. Accurate setting of the arch forms at the point of contact with the invert was secured by grinding down high spots.

A collapsible steel arch form was mounted on rails laid on the invert. This form had hinged retractable bottom portions which permitted the whole frame to be telescoped for movement ahead 18 hr. after the concrete had been deposited. Concrete was pumped into the arch form through an 8-in. line at the average rate of 26 yd. per hour. Doors in the forms permitted the entry of men to work the concrete into place and manipulate vibrators.

The circular section has a minimum thickness of 18 in. and the horseshoe section 24 in. The amount of concrete per lineal foot averaged 4.5 to 6.5 cu.yd. After the tunnel was completed voids between the lining and rock were grouted with 1 to 2 cement mortar.

Personnel

The Colorado-Big Thompson Project, of which Green Mountain Dam is a unit, is being constructed by the U. S. Bureau of Reclamation, for which John C. Page is commissioner, S. O. Harper, chief engineer, and J. L. Savage, chief designing engineer. On this project Porter J. Preston is supervising engineer and R. B. Ward, construction engineer. The general contractor is the Warner Construction Co. of Chicago, for which Frank J. Kane was superintendent on the tunnel and Walter N. Hill is chief engineer.

Visibility of Road Signs

TESTS MADE in Connecticut on the legibility distances of highway signs as a factor in the control and safety of traffic, have included the efficiency of direction arrows. These tests, made under the direction of the State Highway Department and the Yale Bureau for Street Traffic Research, were intended to show what form of arrow gives the greatest visibility distance. As reviewed in "Traffic Engineering" (official publication of the Institute of Traffic Engineers) by Stephen E. Butterfield and T. W. Forbes, several questions had to be considered: (1) Is a skeleton or a solid head more easily seen? (2) Is a 30-deg. angle or some wider angle preferable? (3) Is a short shaft as efficient as a long one? (4) Is it of any value to increase the width of the shaft or the whole arrow? (5) how far can a wood arrow, cut to shape be seen in daylight against a snow background? (6) Is it feasible to enlarge the present 4-in. letters without increasing the 9x52-in. size of wood signs as used on highways in Connecticut?

On 59 different arrow designs, 4,600 observations were made by 39 observers, 19 from the Yale bureau and 20 from the highway department. The designs included a solid painted black arrow on a white background, a white board cut to the shape of an arrow; a white arrow outlined in black paint on a board, and an arrow formed by a pair of lines at 60 deg. on a white board. The painted arrows were 4, 6 and 8 in. wide across the points. All the 6-in. and some of the others had reflectors. As representative of practical conditions, the visibility distance was taken as such that an observer can recognize the shape and direction of an arrow but cannot distinguish its design.

With 24 arrows set up on posts, observers (at a distance) walked forward until they could read the most legible sign, and then recorded the distance, as marked in 20-ft. intervals. The signs were then changed as to position and direction, and a second set of observations was made. For night observations, the observers were in or around a car whose headlights illuminated the signs. The night condition is considered critical in evaluating the efficiency of highway signs, and in some cases the most legible design by day was not so good at night, when reflectorized. While the analysis of results is not yet completed, it is reported that the best designs of painted arrows gave a visibility distance of more than 50 ft. to the inch of height.

DELAWARE AQUEDUCT IX

Caissons for a Cutoff Wall

Contents in Brief*—To build the cutoff wall in Merriman Dam it will be necessary to penetrate water-bearing material to a depth of 180 ft. It was judged that the pneumatic caisson method might be best adapted for this construction, provided groundwater could be lowered to keep air pressures within permissible limits. To test the practicability of this idea two exploratory caissons were sunk, described here with the conclusions reached.*

AT MERRIMAN DAM of the Delaware water supply for New York City borings and other evidence indicated a maximum depth to rock of 180 ft. of heterogeneous material, making design and planning for construction of the cutoff wall difficult. The material which was found ranged from boulders through glacial till to running sand or silt or rock flour, and much of the material was water-bearing. There was artesian flow from the vicinity of the seamy upper part of the rock and from some points in the overburden. The horizontal extent of the several water-bearing deposits, their connections, if any, with Rondout creek and with each other, and the quantities of water which they would supply were unknown.

Sinking a line of reinforced concrete pneumatic caissons and sealing them to sound rock and to each other was judged to be the safest and most certain method of meeting these conditions provided that the groundwater could be so lowered as to keep air pressures within permissible and economical limits.

The cutoff of Wyman Dam (*Construction Methods,* July 1930, p. 38) near Bingham, Maine, had been built by the caisson method in 1929, through somewhat similar materials; the depth, however, was less than 100 ft. and friction hung up many caissons before they reached rock.

The cutoffs of the dike and dam of Quabbin reservoir (*ENR,* Aug. 24, 1933, p. 215) in Massachusetts were built by this method in 1931-35 through 130 and 120 ft. respectively, of water-bearing sands, gravels and boulders. Here the groundwater was lowered by pumping from the caissons. By pumping from pilot caissons at each site, and from subsequent caissons, groundwater had been lowered as much as 90 ft. Caissons were then sunk with 25 lb. or less of air, and about three-quarters of the footage was gained under free air.

To prove the practicability of the method at Merriman Dam two exploratory caissons were sunk at the deepest part of the bedrock valley. Further objects of the caisson sinking were: (1) to demonstrate completely the material which was to form the foundation of the dam; (2) to indicate the cost of the pneumatic caisson method under local conditions; (3) to assist contractors in bidding on the remainder of the cutoff; and (4) to permit lowering the groundwater before bids were asked on such remainder. By the method of pumping down the groundwater as sinking progressed, these caissons were sunk to rock.

Test installation

The reinforced concrete caissons (Fig. 2) were started from the bottom of a 17-ft. cutoff trench of 80-ft. bottom width. This trench was intended to drain by gravity, through a culvert and tide gate, into Rondout creek. However, in order to exclude turbid and polluted water from the creek it was found necessary to pump water from a sump to a settling basin where it was chlorinated.

The caissons were spaced 48 ft. apart in the clear, both to leave room for a future 45-ft. caisson between them and to guard against the escape of air from one caisson interfering with pumping from the other. The caissons were 15 by 38 ft. in plan, and reached an ultimate height of 180 ft.; they were made short and wide the better to accommodate pumps and to increase the weight per square foot of surface exposed to soil friction.

The caisson shoe was built up of two 6x8x1-in. angles; the 8-in. legs were placed back to back, and a 1-in. plate 4 ft. high was riveted to the 6-in. legs, welded at the corners and securely anchored into the concrete to form a true cutting edge. The working chamber varied from 7 to 8 ft. in height above the cutting edge.

Caisson equipment

Access was gained by two muck shafts 4 ft. in diameter and one man shaft 4 by 6.5 ft. The man shaft contained a five-man electric elevator with pushbutton control and safety gates on cage and landings, also a safety ladder screened from the hoistway and with rest-and-passing landings at 15.5-ft. intervals. In each caisson there was a pumproom opening out of the man shaft, with floor 14 ft. above the cutting edge, large enough to accommodate four 1,250-gpm pumps. Suction pipes extended through the roof of the working chamber, and a sealing gate in the man shaft afforded an air- and watertight closure between the pump and working chambers.

All pump discharge pipes, air and other pipes, and conduits for electric wiring, were built into the concrete as the caisson was built up. A vertical groove of trapezoidal section and 18 in. deep, starting 9 ft. above the cutting edge, was formed in each end of the caisson to provide for a seal with the adjoining caissons of the final cutoff wall. The concrete, which was heavily reinforced throughout, was flush with the outside of the shoe; the caissons were built without batter, and all exterior surfaces and interior shafts were cast against steel forms. To provide for the attachment of air locks 6-ft. anchor bolts were built into the top of the concrete around each shaft wherever needed, and when sinking under air two large muck locks and one man lock with seating capacity for 24 men were installed.

Alongside each muck shaft, on the long axis of the working chamber, a 6-in. plumb pipe 17 ft. long, extending from a handhole at its top to the roof of the working chamber, was built in. By means of a plumb line suspended from the top of this pipe to the working chamber the mucking foreman could detect and measure tilt of caisson in any direction.

To permit draining successive waterbearing formations which were separated from one another by masses of more or less impervious material (which might prevent drainage downward to the working chamber) sets of four 6-in. wellpoint sleeves were built into the caisson. These radiated from each muck shaft at about 20-ft. vertical intervals and were inclined downward about 30 deg. Through them wellpoints could be driven after the caisson was underpinned on rock. Each sleeve extended from a recess in the side of the muck shaft which housed the valve and stuffing box, almost to the outer face of the caisson; the concrete over the end was drilled out before driving the wellpoint. A system of "wash pipes" through which water could be discharged at the surfaces of the caisson to reduce skin friction was also installed but never used.

Sinking the caissons

The caissons were sunk alternately by hand excavation and with pneumatic spades, with no dredging. In general, each caisson was built up by two 15.5-ft. lifts (or 31 ft. at a time) while sinking of the other caisson was under way. Both caissons were sunk under free air to depths of about 35 ft. below the bottom of the cutoff trench; the trench drained the superficial wet sands and gravels. Below this depth air was used mostly in the wetter formations and in running ground; air was generally omitted in impervious ground and in stable ground yielding little water.

The feasibility of the caisson method of building the cutoff, and the feasibility of sinking the exploratory

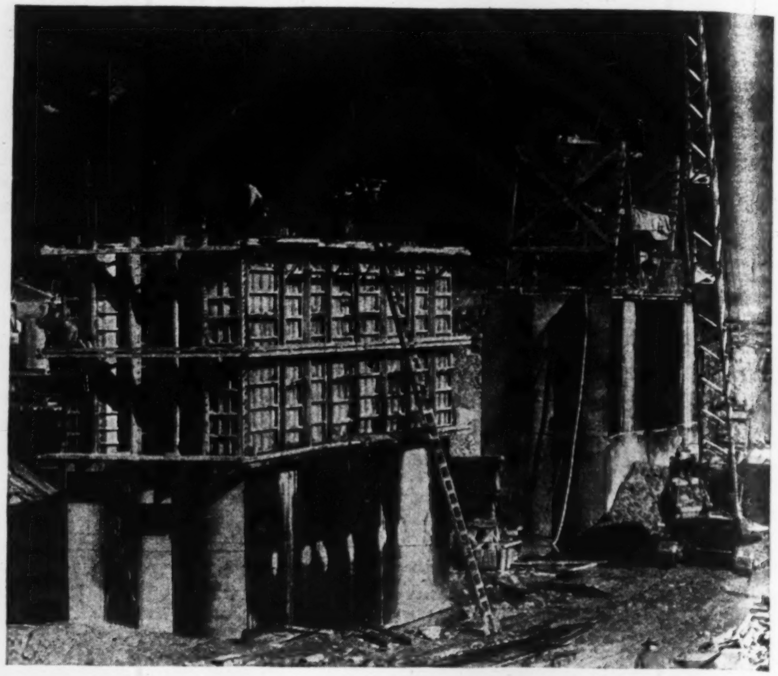


Fig. 1. Exploratory caissons for the Merriman Dam cutoff wall.

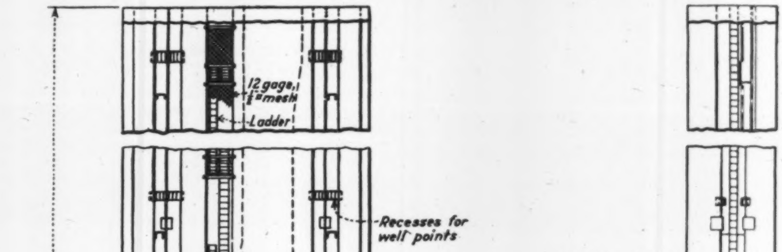

179'-10"
12 gage, ⅛" mesh
Ladder
Recesses for well points
Rest platform
Continuous steel ladders
Typical well point assembly and recess
4" discharge pipe
8" stand pipe
8" pipe unused
Typical wash pipe assembly
6" plumb pipe
Platforms spaced 20± ft. vertically
Sealing gate
Vacuum tanks
5" suction pipes
Wood ladder
Sump
6" suction pipes
Underpinning
3" grout pipes drilling and for future grouting of foundation
Working chamber
3" grout pipes for future grouting
Elevation 500
Concrete seal
Ladder and platforms installed after sinking and sealing caissons for access to well point system
2" wash pipes
Pump room
Centrifugal pump, 7 stage - 300 G.p.m.
10" screen
2" wash pipes
Working chamber
Cutting edge
Underpinning
Sump
Gravel filter
Culvert, perforated

Fig. 2. Two pneumatic caissons like this were sunk through 180 ft. of alternating water-bearing and impervious materials at the Merriman Dam site. The air pressure was kept to a maximum of 32 lb. by lowering the groundwater.

INFORMATION OBTAINED FROM THE SINKING OF EXPLORATORY CAISSONS

	Caisson A		Caisson B	
Average surface elevation of original ground	685.1		685.8	
Bottom elevation of cutoff trench	668.0		668.0	
Groundwater (initial) elevation	671.7		672.0	
Final elevation caisson shoe — average	514.1		507.8	
Depth sunk below bottom of cutoff trench	153.9 ft.		160.2 ft.	
Elevation of highest point rock encountered	513.6		508.3	
Elevation of lowest point rock excavated	503.6		490.2	
Maximum depth of rock excavated	8.4 ft.		18.1 ft.	
Minimum depth of rock excavated	5.5 ft.		5.7 ft.	
Height, caisson cutting edge to top	179.8 ft.		179.9 ft.	
Size in plan	15 ft. x 38 ft.		15 ft. x 38 ft.	
Deck to cutting edge	8.0 ft.		8.0 ft.	
Thickness of deck at pump chamber	6.0 ft.		6.0 ft.	
Maximum weight of caissons, tons	6,660		6,660	
Loading placed on top, tons	0		0	
Frictional resistance — lb. per sq. ft.	570 to 924		610 to 924	
Working pressure in compressed air — lb. per sq. in. (lin. ft. and % of total):				
Atmospheric	90.5	58.8%	114.9	71.7%
0+ to 18 lb.	24.5	15.9%	14.3	8.9%
18+ to 26 lb.	36.2	23.5%	29.6	18.5%
26+ to 33 lb.	2.7	1.8%	1.4	0.9%
Above 33 lb.	0		0	
Caisson sealed at	25.5 lb.		25.5 lb.	
Maximum tilt of caisson from perpendicular:				
Longitudinal	7.66 ft.		3.12 ft.	
Transverse	1.32 ft.		1.85 ft.	
Maximum drift of top of caisson from theoretic position:				
Longitudinal	2.01 ft. south		1.46 ft. north	
Transverse	0.68 ft. west		1.44 ft. east	

caissons to rock, depended upon lowering the groundwater, particularly the head in the artesian horizon at bedrock. This was accomplished by pumping from the caisson working chambers and from a deep well sunk into the artesian horizon. By these methods the artesian head at test well 26 between the caissons, originally about 180 ft., was lowered about 120 ft. during the sinking, and both caissons were sealed to rock under an air pressure of but 25.5 lb. Continued pumping for three months after the sealing of the last caisson lowered the water in this well about 40 ft. more.

From the bottom of the cutoff trench sinking proceeded under free air to depths of 36 ft. and 34 ft. for caissons *A* and *B* respectively. At these depths and in the second major water-bearing sand, the material boiled up into the working chambers, necessitating the use of air at pressures of 15 to 20 lb.

From depths of 60 to 116 ft. for caisson *A*, and 42 to 123 ft. for caisson *B*, sinking proceeded in free air with pumping at rates up to 52 gpm in caisson *A* and 86 gpm in caisson *B*. These were the maximum rates of pumping from the caissons on a 24-hr. average basis, until they reached the artesian horizon. About 59 per cent of the total sinking for caisson *A* and 72 per cent for caisson *B* was done in free air.

During the excavation of caisson *A* in free air at a depth of 115 ft. following the week-end shutdown, a run-in of sand and fine material occurred chiefly at the north end. This stopped the work and eventually filled the working chamber, rising 9.5 ft. in the south muck shaft. The caisson was tilted until the top was 2.96 ft. out of plumb to the south along the length of the caisson, and 0.42 ft. out of plumb transversely upstream. Notwithstanding continuous efforts to right it, caisson *A* got further out of plumb as sinking progressed; altogether in its 180-ft. height it had a tilt of 7.66 ft. longitudinally and 1.32 ft. transversely. The final tilt of caisson *B* was 3.12 ft. longitudinally to the north and 1.85 ft. transversely downstream.

Bottom drainage

When the caissons reached rock they were underpinned and the weathered and water-bearing rock was excavated to depths of 5.5 to 18.1 ft., about 164 to 178 ft. below the bottom of the cutoff trench. A system of gravel filters and perforated collecting pipes for the collection of groundwater was built the full length of each side of the rock excavation. The suction pipes were led up through the working chamber to the pumps, and the remaining rock excavation was filled with concrete to 2 ft. above the cutting edge, thus sealing the working chamber. Eight 3-in. pipes, from rock to working chamber, to serve as sleeves for the future drilling of grout holes, were built into the concrete seal under the shafts and plugged.

For the purpose of draining the water-bearing material near elevations 630, 560 and 520, fifty wellpoints (averaging 10.3 ft. in length outside the caisson) were jacked into these pervious formations from the muck shafts. Boulders and hard driving prevented setting wellpoints through all of the wellpoint sleeves in these formations. It was necessary to drive through a packed gland of special design to prevent inrush of mud during the driving. These wellpoints discharged through individual valves into the muck shafts, the water being pumped from the working chambers. While the rate at which water entered these wellpoints was small, owing to the limited permeability of the ground, there is no question that they effected a substantial lowering of the groundwater head.

The pump suctions were so arranged that either or both pumps could draw: (1) direct from either or both the upstream and the downstream collecting systems in rock; (2) from the working chamber into which the water from the collecting system could be discharged; and (3) from the pump-chamber sump.

Overcoming skin friction

As a rule the caissons had sufficient weight to overcome skin friction when sinking under free air. Through particularly hard ground studded with numerous boulders, the caissons had a tendency to hang up, even with the excavation carried below the cutting edge. When sinking under air, it was necessary frequently to blow the caisson, dropping the air pressure suddenly in order to start the caisson. In no case, however, was it necessary to apply top load.

Skin friction was computed whenever the cutting edge was free so that the known weight of the caisson was supported entirely by the skin friction plus the air pressure, if any, in the working chamber. Friction varied widely as the caisson penetrated the different formations. The minimum for either caisson was 570 lb. per sq.ft., the maximum 924 lb. These figures represent sliding friction, viz., with the caisson moving.

Other Articles in the Series

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Improved Landfill Practice Saves Money

***Contents in Brief**—After three years' development and refinement of landfill procedure, coupled with disappearance of local citizen protest, present results in New York City are that one-third of city's refuse is disposed of by this method, an area of 120 acres of useless land is reclaimed each year, and an annual saving of $2,000,000 is realized, the latter figure being one-third greater than the saving made two years ago. A recently developed strip system of filling promises further gains.*

LANDFILL DISPOSAL of mixed refuse by New York City has been developed and refined by the city's department of sanitation during the last three years to a point where the gains realized from this method of disposal have been substantially increased. Principal improvements are control of width of dumping front, limitation of the area assigned to the trash pickers, precise adjustment of fill height to desired level of finished fill, regular daily covering, increase of compacting by added bulldozer equipment, systematic spraying with chlorinated hydrocarbon, and hose washing of the refuse trucks after each trip.

Objectionable features overcome

Through these improvements objectionable features of the landfill operations have been progressively reduced and the attitude of citizens in the districts nearest the fill has been changed. Protests now are negligible, and in some cases local interests have asked for early initiation of fill work to convert unsightly waste land into park and playground area. At several fills housing developments are under construction directly adjacent to the completed part of the fill. Fly and rat trouble is noticeably absent.

One direct result of the fill operation is the transformation each year of 120 to 140 acres of marsh or other waste land to usable upland area. Another is the saving of roughly $2,000,000 of disposal cost per year, as against incineration. This saving is obtained from only one-third of the city's refuse; extension of landfill disposal to the total volume would nearly triple the amount.

At present the city is operating 11 landfills, distributed over four of the five boroughs (none in Manhattan). Many square miles of lowland are available within the city limits for such use, though much of this land would require rather long hauls. Location and distribution of the present landfills are such as to give an average length of truck haul of about 4 miles, roughly the same as to incinerators. Of the latter, 12 are operating, while 11 of the older and less efficient ones have been shut down.

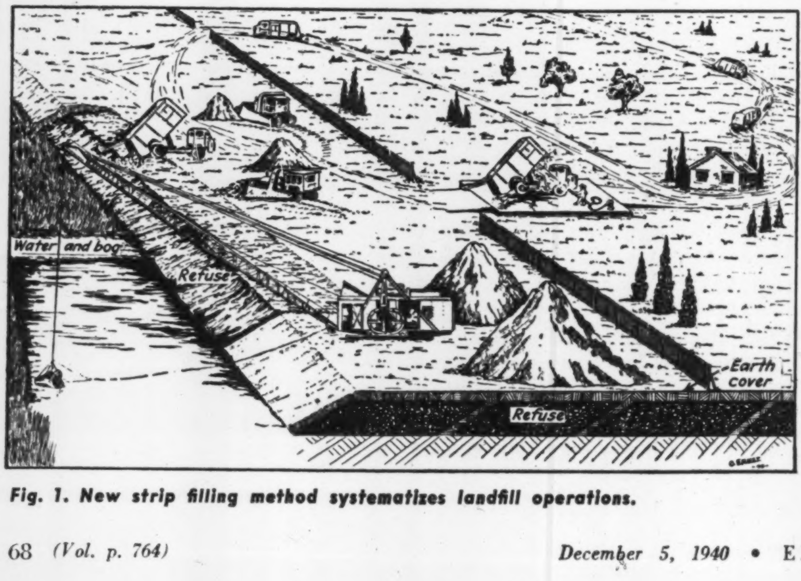


Fig. 1. New strip filling method systematizes landfill operations.

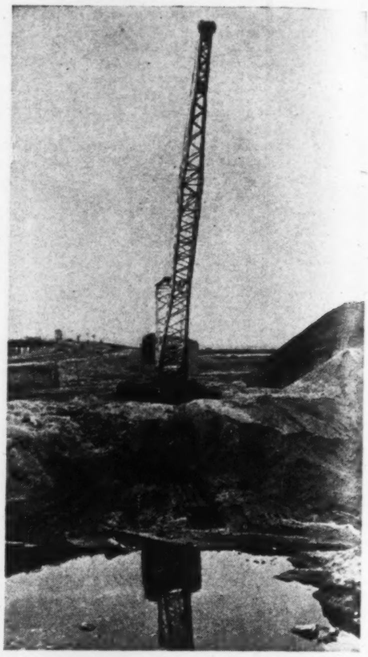


Fig. 2. Dragline crane in operation on landfill adjoining Floyd Bennett Airport. Views on opposite page show dumping, bulldozer used for spreading and placed refuse partially covered with topsoil.

Total city refuse per year is 27,000,000 cu. yd. loose measurement (as loaded in the trucks). Slightly less than 30 per cent of the total is trucked to waterside dump boards, loaded on scows and moved to Rikers Island, in the upper East River, where it is spread as open dump. The other 70 per cent divides about equally between landfills and incinerators. In a few months filling at Rikers Island will terminate and the barge material will go to a large marsh fill area at Soundview Inlet, in the southeastern part of Bronx Borough, for disposal by regular landfill procedure (i.e., as covered fill). With this transfer of disposal operations the total volume of landfill disposal will approach 65 per cent of the city's output.

Comparative disposal cost

Compacted volume, or net volume of finished fill, is equivalent to about one-fourth of loose volume. Thus the compacted or finished volume of landfill now produced per year is 2 to 2½ million cu. yd., representing

an average depth of 15 to 18 ft. of fill over the reclaimed area.

Average disposal costs are 30.5c. per cu. yd. for incineration, 7.5c. for landfill, in each case excluding collection and transportation costs but including interest and amortization. These figures apply to loose volume. Based on an annual landfill disposal of 9,000,000 cu. yd., current savings from landfill disposal thus are about $2,000,000 per year.

Most of the landfills are on city-owned land—either owned beforehand or acquired for the purpose—which is developed as public park and playground areas when filling is completed. A substantial volume of fill also goes into street embankments, where main streets are extended across marshland under private ownership. A case of special use is a fill of 200 acres, later to be extended to 500 acres or more, adjoining Floyd Bennett airport, in the southwestern part of Brooklyn borough, which fill area will be added to the airport for extension of runways and other facilities. Floyd Bennett was the municipal airport of New York City until the completion of LaGuardia Field at North Beach a year ago and thereafter served as alternative or emergency landing field for transport planes until taken over by the army for service purposes.

Park development by landfill

An interesting instance of park development by landfill is the reclamation of a 35-acre tract called Juniper Valley, in the Middle Village district of Queens borough. This was a shallow undrained basin floored with a layer of peat moss up to 20 ft. deep, in the center of a growing dwelling district on the Brooklyn-Queens border. During the last two years the landfill has built up this basin to a height of 35 ft. above the low point, the peat moss being excavated ahead of the fill for fertilizer use by the Park Department. The fill, completed last May, is to be developed as a public park next season, supplementing a playground already developed at one end of the site. Active housing construction is now in progress close to the fill area, and the retarded condition of the region is undergoing a visible change.

Evolution of practice since the initiation of large-scale landfill work by Commissioner W. F. Carey four years ago, and more particularly during the past three years under the detail direction of Deputy Commissioner A. J. Lizee, has centered on development of operating procedure to eliminate all possible elements of nuisance, obtain greatest practicable compaction, minimize long-time settlement, and attain final grade with as little supplementary filling and leveling as possible. Economy in the use of cover material was a factor, as at most sites it would be too costly to haul in upland soil from remote points, and therefore sand skimmed from the top of the low ground just ahead of the fill must be relied upon as cover.

Typical landfill procedure

While practice must in part be adapted to local conditions, the work at the Floyd Bennett landfill shown by the accompanying views is typical. Cover material excavation ahead of the fill is here done by a crawler dragline, and the material is piled close alongside the active fill area so as to require only a single rehandling in placing the cover. The active front of the fill is maintained as narrow as possible—at this particular fill 150 to 200 ft. wide to allow room for maneuvering the arriving and unloading trucks. Trucks (all rear dump) back to within 15 or 20 ft. of the face the fill, are then tilted to dump, and move forward while discharging to clear the load. In the peak hours of the day 10 or 15 trucks are on the fill simultaneously.

Immediately after dumping, the truck is run to a concrete quick-wash platform at the end of the fill, stopping here for two to three minutes while the interior is flushed out with a fire hose. Meantime the pickers (operating under a city-wide contract for which the city receives $20,000 to $30,000 a year) pick over the dumped pile of refuse to reclaim salvage—principally three classes of material: rags, cardboard and metal ware. They are required to avoid interfering with the trucks and bulldozers and to work so that loose paper and other materials do not blow about. To protect further against blowing, portable snow fencing is set up along the leeward side of the fill area.

Two bulldozers (20 tons each) are assigned to the fill, and throughout the shift they move back and forth over the top of the fill to compact it or shove a partly compacted pile of dumped material over the face. Where the strip system of filling is followed they also roll the side slopes.

Beginning in the middle of the afternoon the dragline moves alongside the working area and covers the exposed top surface, taking sand from the piles previously built up alongside. A cover depth of 6 to 10 in. is placed over the refuse. No adjustment of grade is attempted in the covering, as this is the responsibility of the bulldozer operators in compacting and trimming the fill during the dumping period. They keep the front edge of the fill 4 to 6 ft. above final grade, depending on depth of fill, according to the judgment of the fill foreman checked by daily level readings by engineers of the Sanitation Department.

With a normal daily advance of face of 5 to 10 ft., the face of the fill of say 12 ft. finished depth is carried about 6 ft. above final grade; the filled surface slopes back in regularly curved profile for a distance of 200 to 250 ft. to the level finished surface, which represents a virtually stable condition reached after three months or so. Later settlement is of minor amount. Dependent on the thoroughness of compacting and precision of grade adjustment at the face, the top of the finished fill usually shows no local irregularities greater than about 12 in., or general differences of level greater than 2 to 2½ ft.

Recently at two of the fills a strip operating system has been introduced, with excellent success. In this system the fill is carried forward as an embankment about 100 ft. wide on top; after this has been extended to the limit of the field a second strip adjoining the first is filled, and so on in sequence to cover the entire field. As the first strip is filled in, its sides are compacted and flattened by the bulldozers, which back down the slope left in filling and by repeated travel up and down the slope produce a firm side slope of about 2 to 1. In the afternoon cover is placed on the rolled side as well as the top of the fill.

Advantages of the strip system are a controlled narrow face, rapid advance of the face, better compaction by concentration of face work as well as by the side rolling, orderly arrangement of roadways and truck travel, and more convenient work in excavating cover material. While results to date are not sufficiently precise to give a cost comparison of filling under this system with the system of broadside filling previously practiced, the figures are expected to show an economy. Regardless of economy, the advantages in systematizing the work and further reducing odors, etc., are considered to be sufficient to warrant adoption of the system on all of the city's landfills.

Off-Track Machines Handle Railway Earthwork

EARTH-HANDLING EQUIPMENT mounted on crawlers or on road wheels for off-track operation is being used increasingly by railways for their maintenance and improvement work, in place of similar equipment of earlier types mounted on flanged wheels for operation on the track. This was pointed out in a report presented at the annual meeting of the Roadmaster's Association of America, held recently in Chicago. The reason is largely in the increased speeds of both passenger and freight trains, and the consequent desirability of avoiding interference with such traffic by work equipment occupying the track. The newer method is also more economical, and it eliminates the great loss of working time when the work equipment has to keep clear of traffic. As an example of the change, the once general use of work trains with flat cars and unloader plows (or dump cars), in connection with hand or machine ditching, has been replaced to a great extent by off-track equipment such as crawler cranes with draglines, tractors with bulldozers or grader blades, grading machines and power-scrapers.

Crawler cranes equipped as dragline machines are used extensively for ditching, widening and sloping banks, and a variety of other tasks. They are not restricted as to movement and are not delayed by traffic, as is the case with track-operated equipment. Gasoline or oil engines simplify fuel and servicing problems, and with a crew of two men the supervision and attention are reduced to a minimum. A disadvantage when working on the right-of-way is the presence of signal and wire lines. Crawler tractors are operated normally by one man, and may be equipped with bulldozer, plow, grader blade, front-end loader and other attachments for special purposes.

For ditching in long shallow cuts, excellent results have been obtained with a crawler tractor and carrying scraper. On some roads, the crawler dragline machine is used for cleaning ditches, as it permits casting the material back from the slope of the cut, the dragline being operated from the top of the cut and a tractor with bulldozer or grader blade leveling the waste material. Off-track equipment has also proved efficient in the widening of high fills. The excavated material is usually piled in windrows along the toe of the old slope by elevating graders, scrapers or draglines, and then placed on the slope by draglines.

World War Rock Dump Complicates Pier Job

***Contents in Brief**—Piers for a new building at a machine tool plant had to be excavated through a 20-ft. rockfill thrown up during a World War building job. Difficult hand excavation and sheeting improvised to meet conditions as they developed opened up the holes to an underground peat layer. Holes were then backfilled with gravel and piles driven to hardpan.*

GUNS WERE WANTED in a hurry in 1917, and machine tools to make guns—and airplane engines and battleships—are wanted in a hurry in 1940. At the Bridgeport, Conn., plant of The Bullard Co., machine tool builders, a current building job brings the close relationship of these two facts, separated by over two decades in point of time, into sharp focus. The job is the construction of foundation piers through a 20-ft.-deep waste dump of rock for a new bar stock building. Involving back-breaking grubbing of each separate stone in a hole, careful plug-and-feathering of those rocks too large to be handled, and the use of sheeting that had to be improvised piece by piece on the spur of the moment, the job, though small, presented a difficult construction task. And being closely related to national defense, the work was tied to a rush schedule.

The rock dump is the connecting link with the last war and in the following manner. In 1917, the Bullard Mfg. Co., a pioneer manufacturer of turret lathes, took over a government-built foundry and contracted to build a factory parallel and about 300 ft. distant from it for the manufacture of 155-mm. guns. At one end of the gun factory site, ledge rock outcropped to a height of almost 25 ft. To level it quickly, this rock was blasted off in large pieces and dumped in the most readily accessible spot, a tidal marsh immediately alongside and between the gun factory and the foundry. In the subsequent years the gun factory became a machine shop and the rock dump was graded off and became a part of the plant yard. Such was the situation when machine tool orders for the 1940 national defense effort began to roll in.

To bring the whole plant up to maximum efficiency, additional facilities were needed. The foundry, which had been doubled in length to 400 ft. in 1928, was again nearly doubled in length between June and September, 1940. Next a bar stock building was needed where steel could be stored and cut to size before going to the machine shop. The filled ground offered the logical site.

The new bar stock building is 182 ft. long and 100 ft. wide, of steel frame and brick walls. Divided into two bays, 60 and 40 ft. wide, the building has three lines of columns for which foundations had to be provided. A survey of the site showed that the 20-ft.-deep rock dump was over a 10-ft. layer of peat followed by sand, fine sand and gravel, coarse sand and gravel, hardpan and finally ledge rock. Depth to hardpan was variable up to a maximum of 60 ft. High tide level in an inlet immediately adjacent to the site was about at the top of the peat layer.

Any possibility of supporting the building above the peat was out of the question. Experience with an old gantry yard crane whose footings, placed on the rockfill, had settled variously from 1 to 10 in. definitely ruled against such a possibility. The decision, therefore, was to isolate the building piers from the rockfill and to use piles driven into the hardpan. Piledriving through the rock waste pile being impossible, since it was predominantly of large stones, some of 6 and 7-ton size, a major task was presented in removing the rock in the pier locations.

Because of the obvious difficulty of this excavation job the design of the foundations was predicated on the minimum number of piers possible.

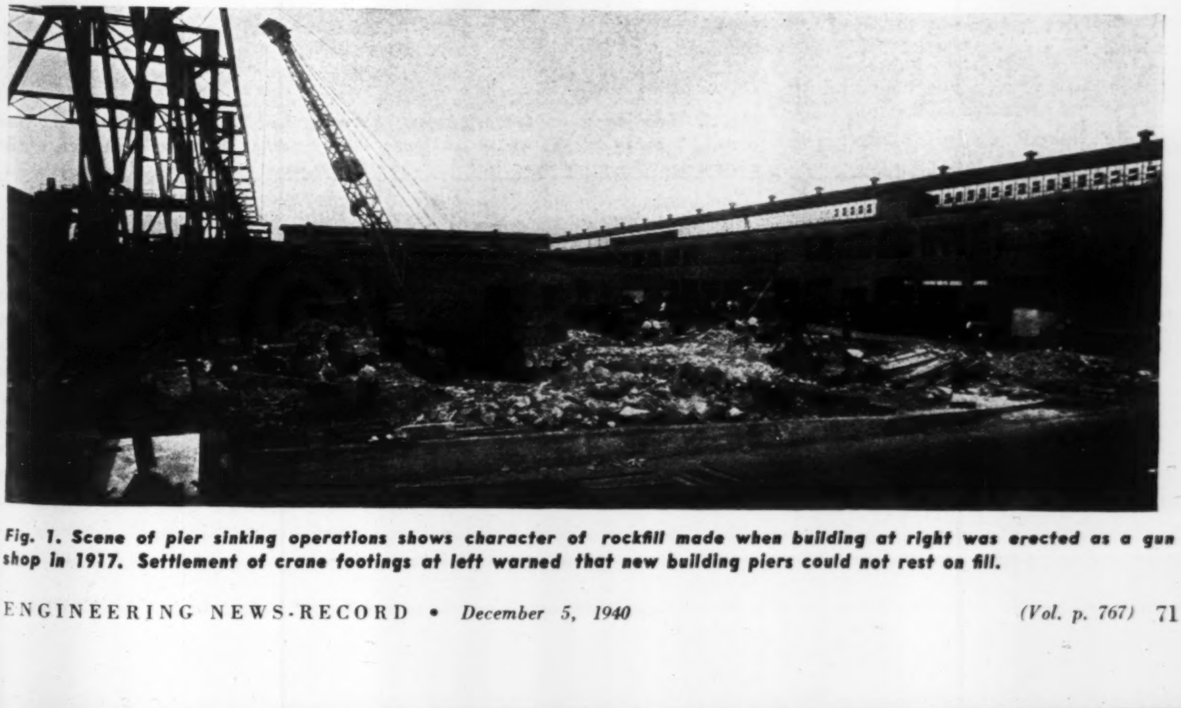


Fig. 1. Scene of pier sinking operations shows character of rockfill made when building at right was erected as a gun shop in 1917. Settlement of crane footings at left warned that new building piers could not rest on fill.

By using concrete beams to span between piers and pick up an extra column in several locations, the number of holes to be excavated was reduced to 20. This naturally resulted in irregular spacing of piers, but some of the irregularity was necessary in any event on the side of the building adjacent to the yard crane to avoid the need for underpinning any of the crane footings. The building piers were of various sizes, of 1, 2, 3 and 4-pile capacity, and from 5 to 8½ ft. square.

Difficult hand digging

Excavation of each hole was an individual problem. And it was almost entirely a hand job. Wherever space was available a clamshell bucket on a crawler crane started the hole, digging it oversize and with sides sloping down to the required dimensions of the sheeted excavation. This operation seldom could go deeper than 6 ft., and was largely confined to the piers on the centerline of the site; along the edges of the site the presence of the crane on one side and a roadway on the other made vertical sheeting from the surface mandatory.

Three men were the most that could work in a hole at one time. Equipped with crowbars and sledges, they worked the small stones loose and placed them in buckets which were hoisted out by crawler crane. When large stones were encountered that filled the hole or projected into it, recourse was had to plug-and-feather drilling to break them up into manageable size; the large broken pieces were removed with chain slings.

Sheeting and shoring the rock

Timber sheeting was placed as excavation proceeded, and the certainty of unequal pressures on the four sides of the hole made this operation a ticklish one. The uneven projections of the rock into the hole made tight sheeting impossible and a crib type was utilized. The horizontal rings of the crib, of 3x12-in. plank, could not be uniformly spaced vertically but were installed as often as possible and never more than 12 in. apart. The horizontal rings were held in place by vertical cleats of 2x4 and 2x6-in. size placed in every available location. In numerous instances single rocks had to be individually shored. Across the hole, 6x6-in. timber braces were installed as opportunity offered and necessity dictated.

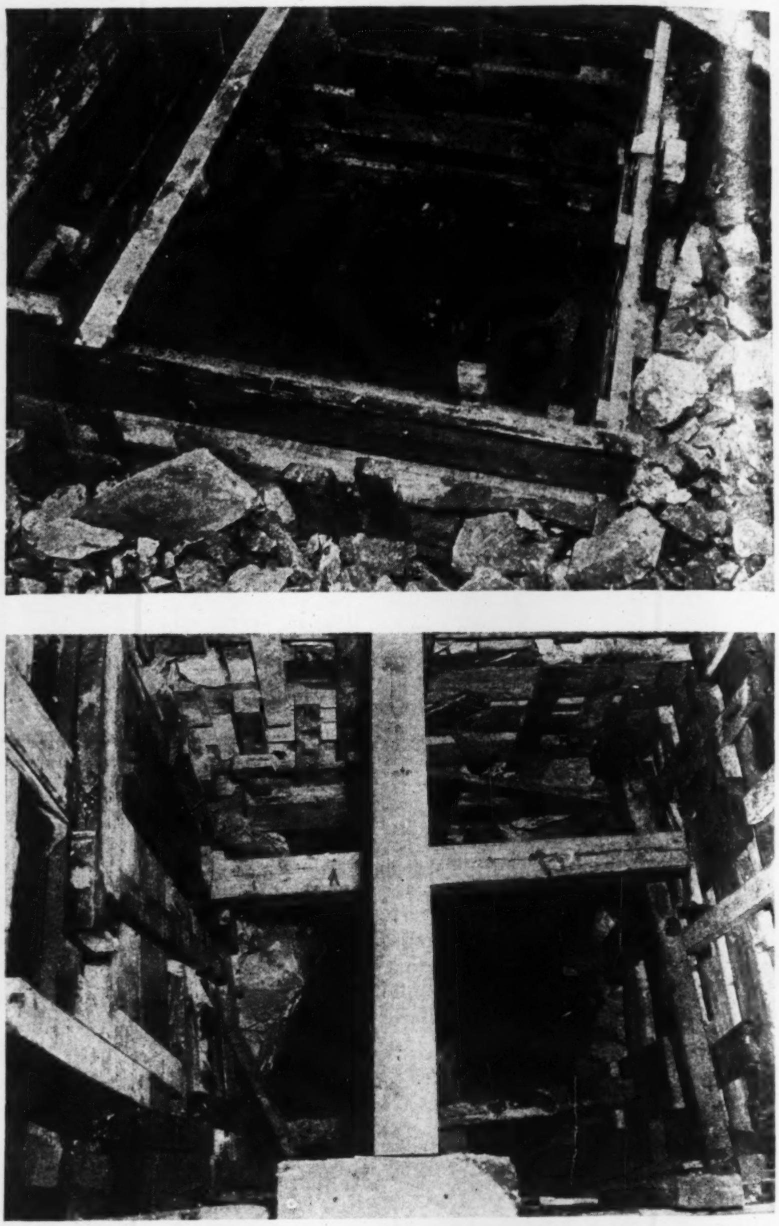


Fig. 2. Looking down typical holes. Sheeting had to be placed as conditions dictated, many pieces doing no more than holding a single rock out of the excavation. Sheeting was left in when holes were backfilled.

Greatest trouble was experienced near the bottoms of the holes where tide level was encountered. Here the rocks were slippery and dangerous to handle. But, although difficult and hazardous, this pier excavation job, requiring the removal of 1,200 cu.yd. of material (800 cu.yd. by hand), was successfully completed without injury to a single workman.

As soon as a hole was past the old rockfill, it was backfilled with bank-run sand and gravel. The 6x6-in. braces were progressively removed as the backfilling proceeded, but all side sheeting was left in place. The poured-in-place step-taper type piles were driven immediately upon completion of a hole. Driven to a penetration of 7 blows per in., the piles, designed for 30 tons each, were from 16 to 60 ft. in length. Pile cutoff was from 3 to 7 ft. below finished grade.

The work was handled by the Turner Construction Co., New York City, for whom E. A. Courter was superintendent. A. D. Crosett, New York City, was consulting engineer.

Work Projects Administration Photos

Fig. 1. Sewer pipe storage on the parade ground does not interfere with training.

Camp Water Supply and Sewage Disposal

Contents in Brief*—To service 4,000 troops and 1,600 animals at a training camp in California called for 1,000-gpm capacity for both water supply and sewerage systems. WPA forces built wells and a storage tank to supply water demands, and constructed a sedimentation and sand filter plant for sewage treatment. Design and construction details are described.*

WHEN THE WAR DEPARTMENT entered into a program with the Work Projects Administration to develop a training camp within the Camp Ord military reservation near Monterey, Calif., an important phase of the work dealt with the water and sewage installation.

The water supply for a small camp originally on the site was obtained from a well drilled to a depth of 250 ft., where the underground storage of the Salinas River was tapped. This well was equipped with a 15-hp electric pump which delivered 75 gpm against a head of 180 ft. The water was pumped to a battery of four 8,000-gal. redwood storage tanks. These tanks, installed on a 20-ft. tower, supplied water to the camp at a maximum pressure of 20 lb. per square inch.

In the layout of a new water system the following factors influenced the design: Ten bathhouses were to be constructed, each one of which had 32 shower heads, 32 lavatories, and 32 toilets equipped with flush valves. The maximum elevation for a storage tank site in the near vicinity, was on top of a hill, 2,500 ft. from the camp area and 95 ft. above it. To provide for all services, it was assumed that 1,000 gpm would be required during the maximum usage period of 70 minutes per day, between 4:30 and 5:40 p.m.

Such an increase in consumption required increasing the capacity of the existing well and providing an auxiliary well and new pumps. The pumps are of a capacity to deliver 400 gpm against a head of 250 ft. and 200 gpm against a head of 240 ft.

Asbestos-cement pipe used

All main water lines are of class 150 asbestos-cement pipe, which was used principally because of its low friction coefficient and the ease of installation. The main distribution system within the camp area is of the loop type with connecting laterals, consisting of 6,000 ft. of 6-in. pipe. The supply is pumped directly into and through this main to an 8-in. main, 2,280 ft. in length, which connects with the storage reservoir. Since the 8-in. main serves as a gravity flow line as well as a force line, it became necessary to increase the size in order to decrease loss through friction. It was found that the 8-in. line would provide sufficient water at the branch takeoffs to give a minimum of 30 lb. per sq. in. pressure when delivering 70 gpm.

Since the maximum usage was to be 1,000 gpm and the maximum pumping supply was slightly under 600 gpm, and since it was considered advisable to confine pumping to daylight working hours, a 200,000-gal. reinforced concrete storage tank was constructed. This tank is 42 ft. in diameter and has a high-water level 21 ft. above floor (Fig. 2).

The tank walls were constructed in three sections, using sectional forms in 7½-ft. lifts. A concrete roof, supported on 4 square columns, was poured last; this roof slab is an integral part of the columns, but is not tied to the exterior wall.

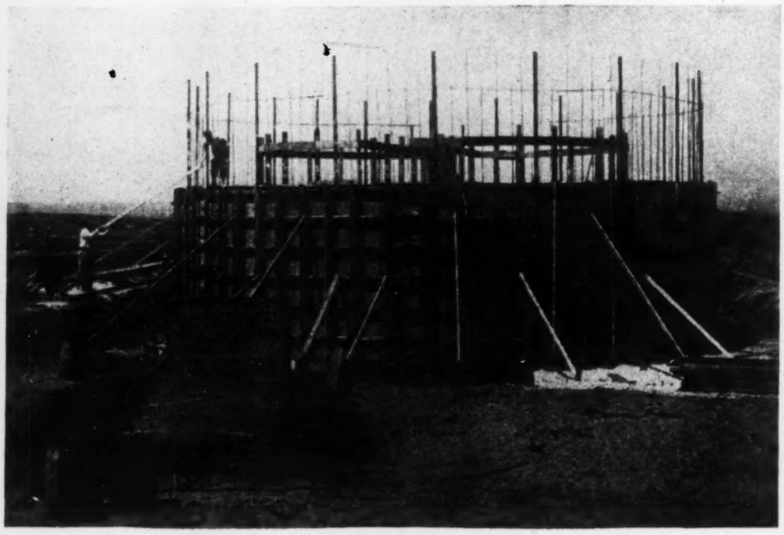


Fig. 2. To meet the maximum demand of 1,000 gpm from a 600-gpm well supply, a 200,000-gal. concrete reservoir is built.

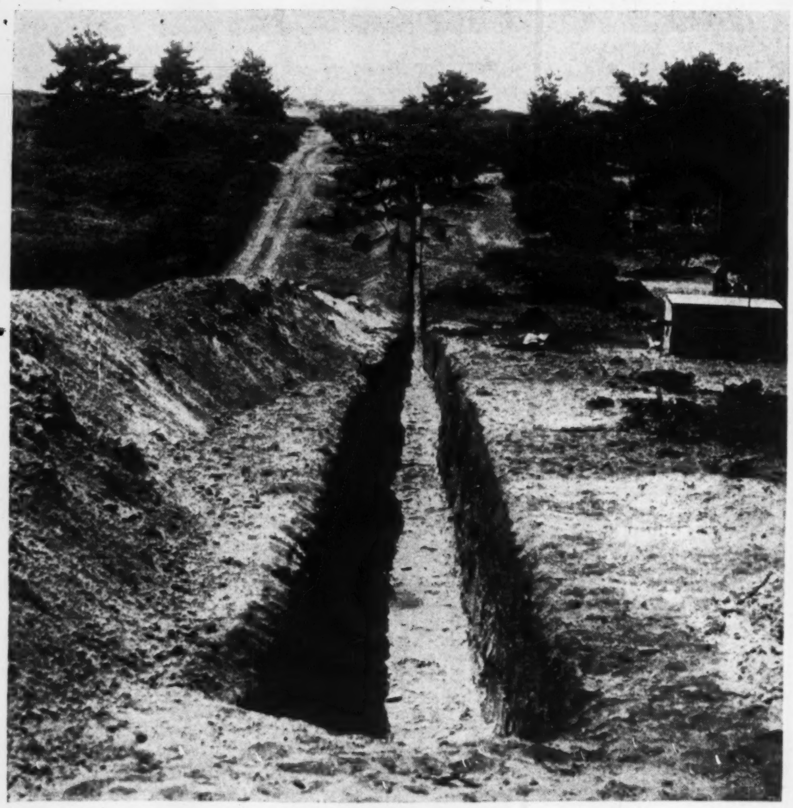


Fig. 3. Trench for water main. The distribution system, of 6 and 8-in. pipe, is of the loop type with connecting laterals.

In planning the sewer system, it was necessary to provide for removing waste water at the rate of 1,000 gpm during a peak period. Since the camp is constructed at a low point of the area it was necessary to slope the collecting lines to two central sumps and then pump the raw sewage to an elevation 72 ft. higher than the camp area. Treatment facilities at this high point include a battery of settling tanks and sand filter beds.

All collecting lines are of vitrified clay tile with cemented joints. The sizes vary from 4 in. as a minimum to 12 in. All kitchens and administrative units are carried on one line to a sump in which a 200-gpm vertical sump pump is installed. This unit pumps the raw sewage through a 6-in. asbestos-cement (class 150) pipe to the treatment tank.

All bathhouses are carried on one line to an underground sump in which are installed two 500-gpm horizontal sump pumps. The complete units—sump, pumps and control equipment—are housed in a reinforced concrete structure, the top of which is at ground level. Raw sewage from this unit is pumped to the treatment tank through a 10-in. asbestos-cement pipe.

The sedimentation unit is a reinforced concrete structure consisting of six settling chambers. These are divided into two batteries, each battery being served by a siphon. The siphon chambers, each of which has a capacity of 7,700 gal., automatically discharge to sand filter beds. All settling tanks are bottom-connected to a 10-in. cast iron pipeline for periodic removal of sludge, which is discharged to a drying bed. It is expected that it will be necessary to remove sludge from the settling chambers not oftener than once a year.

Filter bed construction

Ultimately, three filter areas are to be constructed, each filter bed being divided into six compartments of a sufficient size to accommodate one-half the effluent from a single discharge of a siphon chamber. Two beds are now built. In constructing the filters it was necessary to excavate to a loose sand which was found at an average depth of 14 ft.

Due to the type of soil it was necessary to plant the slopes of each bed to prevent erosion. A rapid growing, non-irrigated ice plant, a species of the cacti family, common to the peninsula, was used with great success, and within six months' time the slopes were heavily matted.

Diversion of effluent is managed by a distribution line, running the long axis of the filter bed, in which are installed distributing manholes at central points. Irrigation gates are installed to control the proper quantity of effluent in any one filter bed compartment.

The work was performed by the Work Projects Administration under the control of William R. Lawson, administrator for northern California; and under the direction of Robert W. Mead, district manager, District 9, northern California; E. P. Pulliam, project director of Monterey County; and Richard R. Sturm, project superintendent.

From Field and Office

Working problems and time-saving methods for engineers and contractors

Clamp for Aligning Pipe

This clamp has been devised to assure alignment of pipe during pipe welding. An 18-in. length of about 2½x2½-in. angle forms the base. A bracket with welded nut holds a bolt which clamps any size pipe into the V of the angle and holds it rigid while welding.

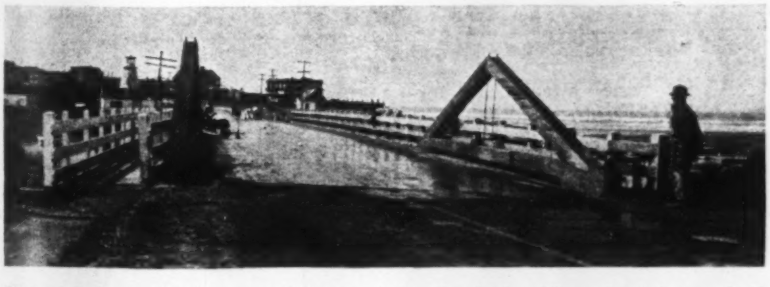
Linde Air Products Co. Photo

Installing 50-ft. Stop-logs

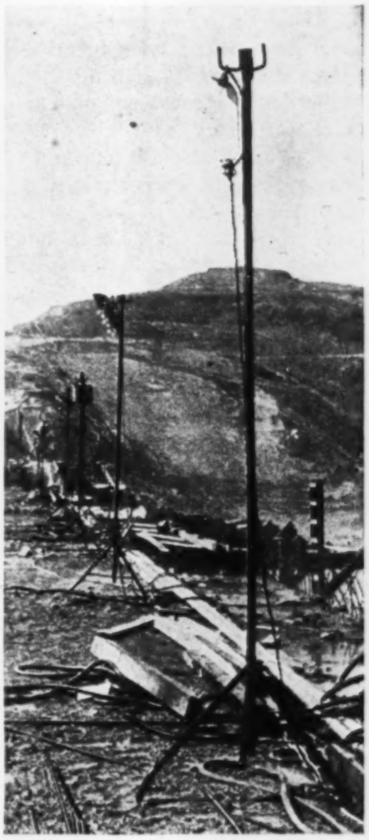
Towards the end of construction of the La Tuque development on the St. Maurice River in the Province of Quebec, the river was passing through the dam in one 50-ft. opening and three 21-ft. openings. The large one was closed first, using for the purpose a set of steel stop-logs which went with the main sluice gates as permanent equipment. The static head upstream was 12½ ft. initially, and it rose to 17 ft. as the logs were placed and the 14,000-cfs flow diverted to pass through the smaller openings.

It was thought that the logs might need to be driven down, so an air pile hammer acting on a 10-in. H-beam post was provided at each end. These posts, which fitted into the stop-log grooves, had latches to engage the logs for handling and for release as each log was seated. This apparatus weighed 8,400 lb.; and the logs, made up of two 24 or 36-in. beams with a skin plate weighed about 21,000 lb.; giving a total of some 29,400 lb. to be handled by two derricks, one on each side. With the flow existing at the time, there was no need of using the air, and the logs sank quietly into place.

The only measurable quantity which would give an indication of the horizontal force on a log was the static head, taken from equivalent still water level down to the centerline of the log when seated, and this was combined with the area of the log to find a horizontal pressure. The ratio of weight to horizontal pressure was found to be 0.38 for the first or bottom log; 0.34 for the second and 0.41 for the third; with higher values for the subsequent logs which were, of course, heavier than was necessary at the time. These ratios unfortunately merge the coefficient of friction of oak seals, well greased with common beef tallow, on steel guides under water, with the effect of hydrodynamic forces: and they do not show how light a log would just go down. However, they do give a little quantitative information which may be of use in future designs. The work was done by the Shawinigan Engineering Co., Ltd., Montreal.



Timber trusses that temporarily support trestle deck while a bent is repaired.



Welded Floodlight Supports

Supports for elevating electric lights above the working area on Grand Coulee Dam, made up from old materials in the pipe yard, have been found both effective and convenient. Usually a 1½-in. pipe post about 12 ft. long is provided with a welded tripod base consisting of 1-in. pipe. Three hooks made of light reinforcing bars are welded to the top of the post so that the lights and their reflector can be hung on the side where the lighting will be most effective. Used as here shown, a row of these lighting standards illuminated the crest of the dam much as permanent light standards would provide night lighting on a bridge.

Trusses Carry Trestle Deck For Bent Renewal

Where repairs or replacements are necessary in pile bents or in the intermediate frames of trestles, the Oregon State Highway Commission supports the deck temporarily on simple timber trusses designed for convenience in moving. The trusses are of the king-post type and are sufficiently strong to carry the usual highway traffic while repairs are under way.

A pair of these trusses is spotted over the bent to receive attention and holes are bored through the deck for bolts that suspend auxiliary caps on each side of the cap to be relieved of load. When a new bent on cutoff piles or on concrete pedestals is in place and ready to take its load, the auxiliary caps are taken out and the trusses are moved to the next location.

Fenders Protect Bridge Trusses on Oregon Highways

The risk of serious damage to bridges that arises when motor trucks collide with truss members in through bridges has been reduced by the Oregon State Highway Commission by slide rails or fenders placed as shown in the accompanying views.

The hazard is greater where there is a curve on the approach to the bridge, as in top illustration, or where the bridge roadway, as in bottom illustration, has a width less than modern standards require. In the case of the steel bridge, the slide rails are 15-in. steel channels; in the timber truss, timber rails are used.

IMPAIRED CLEARANCE

Slide rails made of steel channels protect truss members where approach to bridge is on curve, as at top. At bottom: timber slide rails in narrow bridge decrease collision hazards

Exhaust Steam Warms Hoistman

Exhaust steam from the hoisting engine during periods of activity, together with live steam bled from the line during lulls, makes livable the post of hoist engineer on a construction job throughout the colder months. As illustrated, a radiator of vertical lengths of 2-in. pipe carried in a 4-in. header serves as a condenser-heater. When the hoist engine exhaust is turned into the end of the header, the cooling effect of the ample radiation surface acts as a condenser and increases the effective power of the engine. A valve on a branch from the steam line permits steam to be bled into the radiator when the engine is not used, or to maintain working temperatures during exceptionally severe weather.

A trap and drain on the outlet from the radiator returns the condensate to the sump from which the boiler feed pump draws its supply, eliminating scale trouble in locations where native water must be treated before using. — ELTON STERRETT, *Longview, Tex.*

Rock Basket Scoop and Elevator

A job-made attachment for a tractor to be used in loading rock was built up by the contractor on Hansen Dam in southern California. It has speeded up the handling of coarse rock used for paving on the upstream face. On this job quarry rock for the paving is dumped near the upstream toe. After being broken to size for paving, the fragments have to be picked up, lifted and dumped into motor trucks.

The basket itself consists of a V-shaped assembly of steel plates and bars with a hoisting mechanism that permits of raising the basket vertically 8 or 10 ft. To load the basket, the tractor crowds it forward into the rockpile and then tilts it back to retain its load. The tractor then withdraws and while it moves toward the truck, the basket is elevated to a level whence it can be tripped to dump into the truck.

The rig was designed and assembled by the Guy F. Atkinson Co., contractors on Hansen Dam.

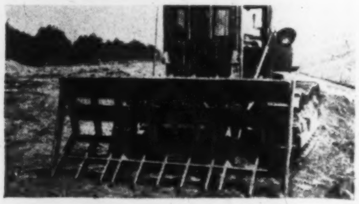


Fig. 1. Front view of the rock basket.

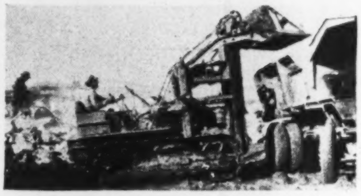
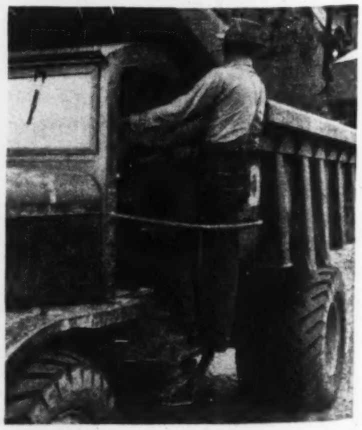


Fig. 2. Load of rock has been elevated ready for dumping into truck.

Safety in Reverse

Pipe makes safety frame to protect driver using auxiliary control pedals mounted on side step of truck. Device facilitates safe, rapid backing of truck for loading or dumping on Utah Construction Co.'s work at Nantahala Dam in North Carolina.



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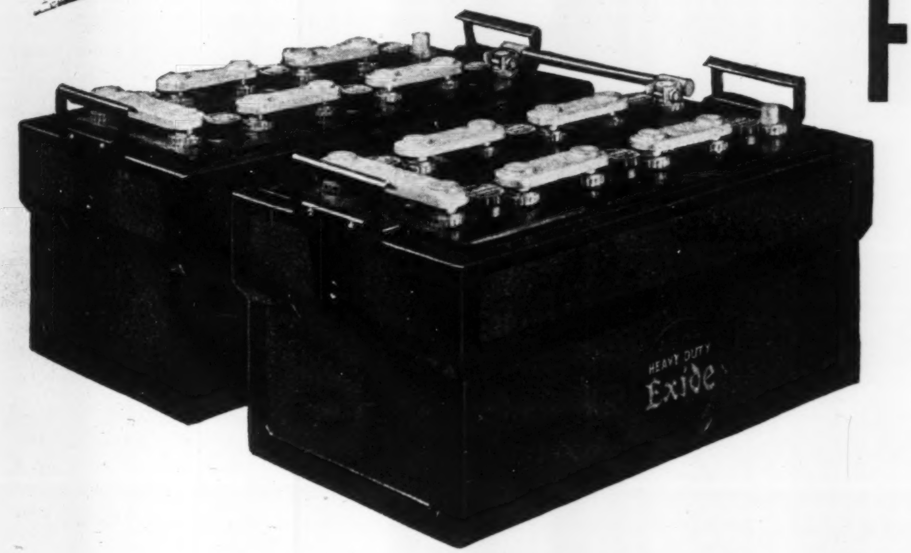
cranks Diesel engines
FAST!



Exide

BATTERIES
FOR CRANKING
DIESEL ENGINES

THERE are many ways to speed up your output. A first essential when using Diesel power is fast, dependable cranking that helps to get the engine on the job as soon as its power is needed.

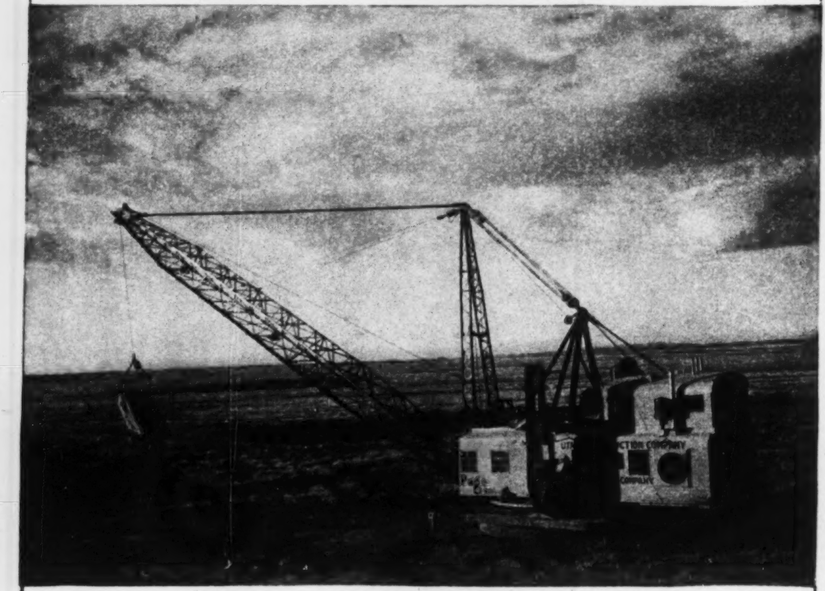
That's why Exide Batteries can speed up production. With their tremendous power, poured out freely even at low temperatures, and their consistently high voltage that insures the needed high cranking speed—Exides save valuable time in starting Diesel engines.

They save time and trouble day in and day out, during the entire long life that keeps their overall cost so low. There is an Exide for every size and type of Diesel engine, from the smallest to the largest. No job is too tough for an Exide. These batteries are helping to speed up output wherever Diesel engines are used. Why not write us today?

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

PAGE TWO-ENGINE DIESEL-POWERED WALKING DRAGLINE

One engine for loading and hoisting
Another separate engine for swinging



On canal work near Tucumcari, New Mexico, Utah Construction Company and Griffith Company use this Page Walker, powered by two Page horizontal Diesels, one mounted above the other. A heavy-duty 6½-cubic-yard Page Bucket is used on a 110-foot boom.

Here is a new development in large draglines—fast hoist and fast swing at the same time! No longer need the operator delay the swing of the machine waiting for the hoisting of the bucket. Rather, with the balanced power of the Page Two-Engine Walker, acceleration of hoisting and swinging is greatly increased.

To understand this faster operation with a Page Two-Engine Walker, visualize using all of the power of your present dragline for hoisting only, without swinging the machine. You will find that the hoisting speed will be increased greatly. Now consider a second independent engine for swinging only. This second engine accelerates the swing in proportion to the faster hoist. The two engines—the large Diesel, which only hoists and loads the bucket, and the smaller independent Diesel for swinging as rapidly as the faster hoist demands—furnish perfectly balanced power and increase the number of loaded buckets that can be handled per minute. Learn what a Page Two-Engine Walker will do on your dragline job.

PAGE ENGINEERING COMPANY
Page Automatic Dragline Buckets · Page Walking Dragline Machines
CLEARING POST OFFICE, CHICAGO, ILLINOIS

Leon Bieri, formerly with the Bureau of Reclamation, has now begun duty at Fort Bliss, Tex. as a first lieutenant. He was formerly with the Colorado State Highway Department. While with the Bureau of Reclamation he was employed on Vallecito Dam.

Joseph M. Bayern, draftsman in the design section of the Huntington, W. Va. district office, U. S. Engineers, has resigned to accept private employment.

James B. Ramsey, graduate of the University of Kansas, has been named chief draftsman to the water department of the city of Omaha. He succeeds **Jesse L. Lamm**, who will continue with the department as draftsman. Ramsey formerly worked with the Kansas State Highway Department, and Burns & McDonnell.

R. S. Calland, who has been assistant supervising engineer with the Bureau of Reclamation under **Walker R. Young**, now assistant chief engineer, has been appointed acting supervising engineer in general charge of activities in California. Calland, following work on Boulder Dam, was transferred to the Central Valley project office at Sacramento, Cal. in January, 1937. He has been with the bureau a total of 17 years.

H. W. Blandford, who served as construction advisor for the USHA on a low cost housing project at Wilmington, N. C., is now working at Newport News, Va. as construction advisor on three defense housing projects.

William H. Nalder, formerly chief designing engineer with the Bureau of Reclamation, has been promoted to acting assistant chief engineer. Nalder, who graduated from Washington State College in 1909 with a civil engineering degree, before joining the Bureau of Reclamation worked with the Walla Walla & Western Ry. With the bureau he has worked on the Tieton project, Yakima project, and the Sun River project.

Col. Earl I. Brown, retired in 1938 after many years with the U. S. Engineers, has been temporarily recalled to active duty to act as district engineer at the Wilmington, N. C. office. He succeeds **Lieut. Col. William Gillette**, who recently was ordered transferred to Fort Belvoir, Va. After graduating from West Point in 1898, Brown was assigned the Wilmington district for one year as assistant engineer. For 2½ years he served in the Philippine

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GASOLINE MOTORS
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East — west — north — and south — you will find authorized Service Stations, manned by factory trained men equipped with special factory tools, ready to take care of any emergency — to adjust, repair, or rebuild any model of Briggs & Stratton motor, even though it's a veteran of 10 or 20 years of service. This nation-wide authorized factory service is maintained to protect your investment in Briggs & Stratton gasoline motors — an important added advantage recognized by manufacturers, dealers and users.

BRIGGS & STRATTON CORP.
MILWAUKEE, WISCONSIN, U. S. A.

4 CYCLE
BRIGGS & STRATTON
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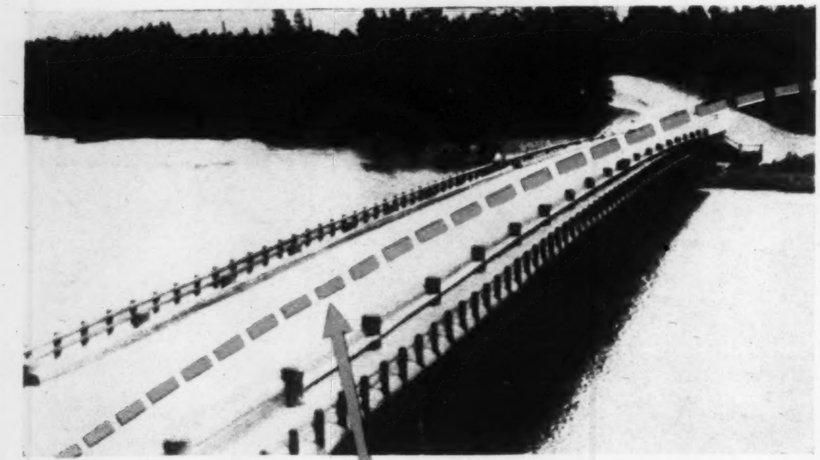
IT'S POWERED RIGHT WHEN IT'S POWERED BY BRIGGS & STRATTON



TRY THIS *Line of Attack*

FOR BUILDING LONG-LIVED BRIDGES CHEAPER!

You can build a bridge for less by constructing with timbers. Will it endure? Attack that part of the problem by using Wolmanized Lumber*, and you clinch your saving, you get *long-run low cost.*

Fourteen cars of Wolmanized timbers were used to construct "Fishing Bridge" across Yellowstone River. Lower illustration is Cow Creek Bridge, near Redding, California, built with 21,109 feet of Wolmanized Lumber, at a total cost of $9,769.70.

That illustrates the principle which makes Wolmanized Lumber a money saver in scores of applications, ranging from oil derricks to private dwellings: Construction with lumber saves; the endurance of Wolmanized Lumber, which is protected against decay and termite damage, nails the saving down.

Wolmanized Lumber is free of the disadvantages commonly encountered in treated material; is clean, dry, odorless, and easy to handle. It is the only *pressure*-treated lumber which is always treated according to one standard set of specifications, and is sold throughout the country under a single identifying name. You can depend on it.

If you would like complete information about Wolmanized Lumber, we shall be glad to send you the booklet "Wood Preservation," and also to answer any specific questions. AMERICAN LUMBER & TREATING CO., 1649 McCormick Building, Chicago.

*Registered Trade-mark

WOLMANIZED LUMBER

Islands, and then as assistant to the district engineer of New York. He also served at Galveston, Tex., Montgomery, Ala., Washington, D. C., Cincinnati, O., Fort Sam Houston and Richmond, Va.

Dow I. Sears, city manager of Huron, S. D. since 1935, has been appointed area supervisor for the Work Projects Administration in Fillmore, Houston and Winona counties, Minn. His headquarters will be at Winona. Sears graduated from the University of Minnesota with a civil engineering degree in 1914. After a year with the American Bridge Co. at Minneapolis, he was employed as water engineer for the city of St. Paul, a position held for seven years. In 1922 he was appointed superintendent of the Ironwood, Mich. water department and in 1929 city manager of Ironwood.

Col. Ulysses S. Grant, 3rd, division engineer at Cleveland for the U. S. Engineers, has been transferred to Chicago. Col. Grant was transferred from the general staff corps at Governors Island, N. Y. to the Great Lakes Division office.

Brig. Gen. John C. H. Lee, division engineer of the North Pacific Division, U. S. Engineers, Portland, has been transferred to Fort Mason, Cal. General Lee, recently promoted from the rank of colonel, went to the Portland post in 1938 from Philadelphia, where he had been district engineer.

G. Laurence, civil engineer, has been made a member of the teaching staff at the Ecole Polytechnique of Montreal.

Transfers from the U. S. Engineer District Office, Rock Island, Ill. include the following: **Eldron C. Arendts**, junior engineer, to Norfolk, Va.; **Earl G. Buck**, surveyman, Seattle, Wash.; **Vora W. McCoy**, principal draftsman, Seattle, Wash.; **John C. Nelson**, subsurveyman, Baltimore, Md.; **Ora S. Rezner**, subsurveyman, Baltimore; **William D. Schwennsen**, subsurveyman, Quartermaster Corps, Proving Ground, Ill.; **Bill Smiddy**, subsurveyman, Quartermaster Corps, Proving Ground, Ill.; **John V. Story**, assistant civil engineer, Seattle Wash.; and **George E. Wheeler, Jr.**, subsurveyman, Baltimore, Md. Men given furloughs include: **Bernal E. Craig**, principal engineering aide, and **William H. Darrow**, subsurveyman.

Bert C. Wilkas, graduate research fellow in soil mechanics at Purdue University, recently accepted a position as junior engineer at Denver in the earth

CLEAN CRAWLERS
Cut Costs

Simple and rugged crawler construction. Self-cleaning tumblers and smooth-surface shoes.

Clean crawlers reduce wear of crawler shoes, tumblers and rollers. Koehring crawlers are free of dirt collecting traps. Self-cleaning tumblers keep crawlers clean by ejecting mud, sand, gravel, clay and loose earth. The V shaped girders protect the rollers. Crawler shoes have a smooth surface... no pockets to hold caked material. All of these important features of the Koehring non-clogging crawlers reduce wear... cut upkeep cost... lengthen service life.

KOEHRING COMPANY
MILWAUKEE • WISCONSIN

KOEHRING HEAVY DUTY

HEAVY-DUTY CONSTRUCTION EQUIPMENT

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

FLOOD PROTECTION WORKS MUNCIE, INDIANA

OWNER: U. S. Engineer Office, Louisville, Ky.

PROJECT: Construction of flood protection works, wall section, Muncie, Ind., located on right bank of West Fork of White River. Part of work begins at High St. Bridge and extends upstream approximately 2,000 ft.; part begins at Nickel Plate R. R. and extends upstream to Big Four R. R. Involves construction or installation of levee and roadway embankment; concrete walls and paved slope; concrete and steel piling cutoffs; channel excavation; and drainage structures. Portion of existing wall to be removed.

CONDITIONS: Contractor to furnish all material except 198 steel piles which are to be furnished by government but driven by contractor. Time for completion: 270 calendar days after notice to proceed. Rail and highway transportation facilities available. Wage rates specified are: skilled labor, $1.00 to $1.55 per hr.; semi-skilled, 60 to 85c.; and common, 60c.

BIDS: Seven bids were opened November 6, 1940, ranging from the low of $99,617 to $189,237.

LIST OF BIDDERS:

1. Hart & Hart, Columbus, Ind	$99,617
2. Smith & Johnson, Indianapolis, Ind.	107,070
3. Stewart O. Strandberg Co., Chicago, Ill.	111,687
4. G. E. Tillman, Centralia, Ill.	131,762
5. J. T. McCarthy Co., Davenport, Iowa	138,767
6. Pioneer Contracting Co., Evansville, Ind.	147,037
7. Midland Constructors, Inc., Chicago, Ill.	189,237

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. Excavation, structure	6,600 c. y.	$0.68	$0.70	$2.25
2. Excavation, channel	12,000 c. y.	.41	.40	1.00
3. Excavation, rock	900 c. y.	1.90	3.00	5.00
4. Concrete	3,300 c. y.	16.30	18.00	14.40
5. Reinforcing steel	193,600 lb.	.041	.05	.045
6. Furn. and drive st. sheet piling	154,400 lb.	.0486	.06	.06
7. Hand placed riprap	30 c. y	7.00	5.00	4.00
8. Gravel blanket	80 c. y.	1.95	1.20	2.25
9. Backfill, compacted	14,800 c. y.	.77	.50	.40
10. Pipe conn. thru concrete wall	L.S.	372.00	350.00	300.00
11. Vault door and frame	1 ea.	120.00	200.00	100.00
12. Miscellaneous metals	280 lb.	.30	.30	.15
13. Movable closure parts	L.S.	385.00	600.00	250.00
14. 24 in. vit. clay pipe and conc. jackets	64 l. f.	9.80	4.00	4.50
15. 24 in. corr. iron pipe	67 l. f.	4.05	4.00	2.50
16. 36 in. corr. iron pipe	53 l. f.	7.93	9.00	3.50
17. Corr. iron seep ring	137 s. f.	1.10	1.50	1.00
18. 18 in. automatic drainage gate	1 ea.	40.00	60.00	50.00
19. 24 in. automatic drainage gate	2 ea.	60.00	70.00	75.00
20. 36 in. automatic drainage gate	1 ea.	110.00	160.00	150.00
21. Levee embankment	4,000 c. y.	.31	.45	.40
22. 8 in. toe drain	350 l. f.	1.28	1.50	.50
23. Relocation of water main	L.S.	800.00	800.00	700.00
24. Concrete manhole	L.S.	370.00	150.00	200.00
25. Reconstruction of manhole	3 ea.	83.40	30.00	100.00
26. Remove existing structures	L.S.	325.00	300.00	500.00
27. Drive steel sheet piling furn. by govt.	83,160 lb.	.0165	03	.04

HIGHWAYS, NEW YORK

OWNER: Board of Water Supply, City of New York, N. Y.

PROJECT: Construction of approximately 4½ miles of highways and a 3-span steel beam highway bridge and appurtenances, located in Neversink and Fallsburg, Sullivan County, N. Y. Pavement of 2½ miles of highways to be of concrete, balance of bituminous macadam. Highways to be built are around southerly end of proposed Neversink Reservoir. Three-span steel beam bridge to be over Neversink River, 1¼ miles southeast of Neversink. Concrete roadway 20 ft. wide; bituminous roads 18 ft. wide. Bridge supported on steel pile bents to have total length of 165 ft. with 3 spans, each consisting of 5 steel beams supporting reinforced concrete slabs. Bridge roadway 20-ft. wide; 2½-ft. sidewalk on one side.

CONDITIONS: Contractor to furnish all material and complete work in 24 months. Rail and highway transportation facilities available. Wage rates stipulated are: skilled labor, $1.00 to $2.25 per hr.; semi-skilled, 70c. to $1.65; and common labor, 75c. per hr.

BIDS: Seven bids were received Oct. 1, 1940, ranging from the contract low of $457,895 to $683,730.

LIST OF BIDDERS:

1. D. W. Winkelman Co., Syracuse, N. Y. (contract)	$457,895
2. A. D'Angelo & Sons, Inc., New York, N. Y	489,600
3. S. J. Groves & Sons Co., Ridgefield, N. J	502,760
4. Reiss & Weinsier, Inc., Brooklyn, N. Y	547,767
5. Bronx Water Works Corp. and DeBlasio Constr. Corp., Bronx, N. Y	558,890
6. Ottaviano & MacDonald, Inc., Croton-on-Hudson, N. Y.	571,868
7. J. P. Burns, Dumont, N. J	683,730

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. Clearing and grubbing	L.S.	$20,000.00	$38,500.00	$12,000.00
2. Unclassified excavation	230,000 c. y.	.50	.50	.60
3. Earth excavation	7,000 c. y.	.75	1.50	1.25
4. Rock excavation	1,000 c. y.	4.00	4.00	4.00
5. Refilling and embanking	240,000 c. y.	.15	.10	.10
6. Surface dressing and grassing	10,000 c. y.	3.00	2.00	2.25
7. Preparing fine grade	52,000 s. y.	.10	.20	.15
8. Foundation course	3,500 c. y.	2.50	5.00	3.00
9. Temp. gravel pavmt. and run of bank gravel	1,000 c. y.	.75	1.80	1.75
10. Bottom course	2,600 c. y.	3.00	4.50	4.25
11. Top course	2,000 c. y.	3.50	4.50	4.25
12. Bituminous material	110,000 gal.	.10	.08	.09
13. Calcium chloride	10,000 lb.	.02	.02	.03
14. Concrete masonry	1,800 c. y.	17.00	17.00	17.00
15. Concrete pavement	7,000 c. y.	5.00	6.00	6.00
16. Portland cement	16,000 bbl.	2.25	2.35	2.60
17. Natural cement	1,800 bbl.	2.40	2.15	2.70
18. Reinforced concrete pipes	3,000 l. f.	5.00	4.70	4.00
19. Vitrified pipes	1,500 l. f.	75	1.00	1.50
20. Timber and lumber	10 Mbm	60.00	75.00	150.00
21. Steel H bearing piles	80,000 lb.	.05	.07	.06
22. Structural steel	165,000 lb.	.07	.05	.07
23. Misc. cast iron, wrought iron and steel	45,000 lb.	.12	.12	20
24. Steel for reinforcing concrete	260,000 lb.	.05	.05	06
25. Dry rubble masonry and paving	800 c. y.	5.00	5.00	10.00
26. Rubble masonry and paving in mortar	1,600 c. y.	6.00	8.00	12.00
27. Crushed stone and gravel	8,500 c. y.	1.50	2.00	2.50
28. Cable guard rails	20,000 l. f.	1.10	.80	.95
29. Cleaning up	L.S.	2,000.00	5,730.00	500.00

DREDGING, CALIFORNIA

OWNER: U. S. Engineer Office, San Francisco, Calif.

PROJECT: Dredging 2,789,520 cu. yd. of material in San Francisco Bay adjacent to San Francisco municipal airport.

CONDITIONS: Contractor to furnish all material and equipment; 300,000 cu.yd. to be removed during the first month; 500,000 cu.yd. per month thereafter. Water and highway transportation facilities available. Wage rates specified are: fireman, leveeman, deckhand and bargeman, 90c. per hr.; deckmate, $1.00 per hr.; and leverman, $1.30 per hr.

BIDS: Two bids were received November 4, 1940, the contract low, $243,246, and $290,667. Engineer's estimate, $227,923.

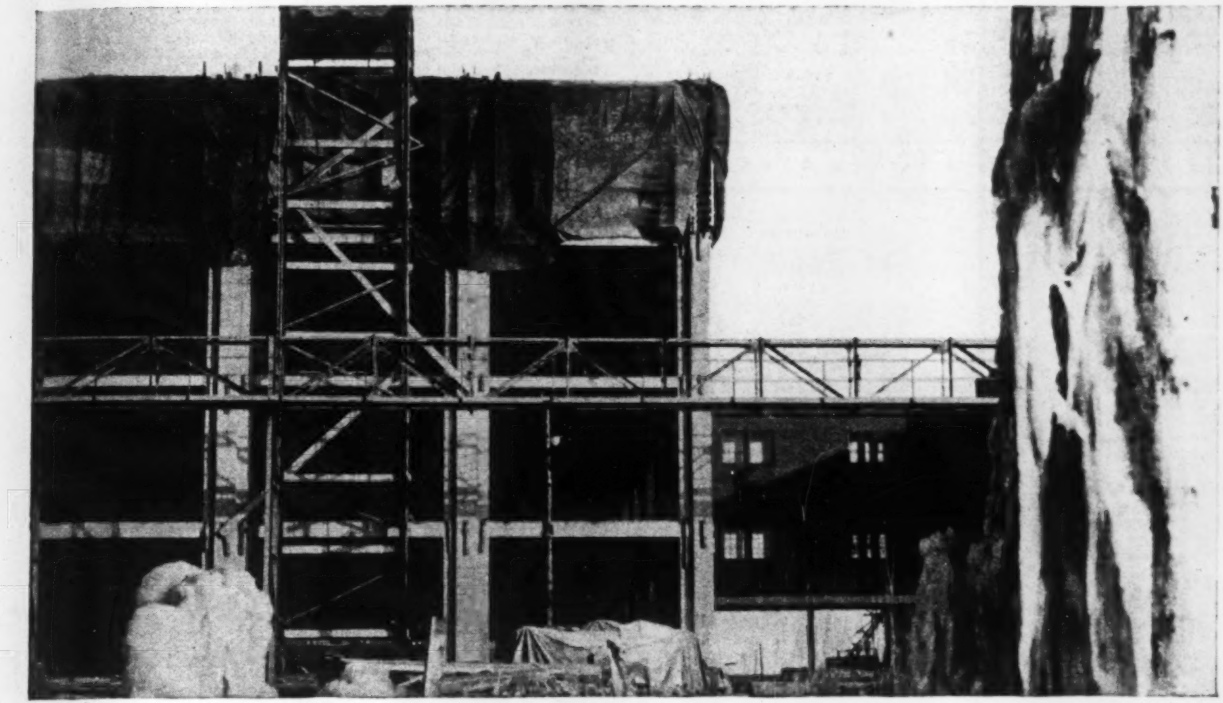
LIST OF BIDDERS:

1. American Dredging Co., Oakland, Calif. (contract)	$243,246
2. Fred C. Franks Contracting Co., San Francisco, Calif.	290,667

Item	Quan.	Unit Prices		
		(1)	(2)	(3)*
1. Dredging	2,789,520 c. y.	$0.0872	$0.1042	$0.08[illegible]

* Unit price in engineer's estimate.

'INCOR' 24-HOUR CEMENT SPEEDS WINTER WORK, REDUCES FREEZING RISK, CUTS HEATING COSTS



Cold-Weather Safety Factor

LONE STAR CEMENT CORPORATION
INCOR
HIGH EARLY STRENGTH PORTLAND CEMENT

QUALITY PAYS . . . INSIST ON 'INCOR'—'Incor' 24-HOUR Cement means just what the name says—dependable 24-HOUR service strength. Plus long-time durability, proved by 13-year performance. Quality pays—because better cement makes better concrete.

WITH temperatures as low as 9° above zero, concreting proceeded at normal speed last winter, on 5-story addition to General Aniline Works' Building No. 48, Grasselli, N. J.—White Construction Co., New York, general contractor. The structure was designed for live loads of from 100 to 500 lb. per sq. ft. Economical 'Incor' concrete design mixes provided dependable high early strength, permitted form stripping in 2 days, without the use of reshores. *'Incor' saved $1,150 on heating-fuel expense, alone.*

'Incor' cures and hardens 5 times as fast, is safe from freezing that much sooner; that cuts heat-protection costs 50 to 60 percent, and permits normal stripping schedules with safety, even at sub-freezing temperatures.

Use 'Incor'* on work now in progress—it's a proven cold-weather safety-factor, sure enough. Write for copy of "Cold Weather Concreting." Lone Star Cement Corporation, Room 2279, 342 Madison Avenue, New York.

*Reg. U. S. Pat. Off.

LONE STAR CEMENT CORPORATION

MAKERS OF LONE STAR CEMENT · · · 'INCOR' 24-HOUR CEMENT

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

Lumber provides the only major change in the December construction material price list. Short Leaf Yellow Pine is $1.50 to $2.00 higher in Baltimore; up 50c. to $1.00 in Chicago; up $4.00 to $6.00 in Cincinnati; up $1.00 to $2.00 on most sizes in Dallas; up $1.00 in New York and St. Louis; up $12.00 to $15.00 in Pittsburgh; and 50c to $1.00 lower on 2-in. sizes in Birmingham.

Douglas Fir is $2.00 higher in Baltimore and Seattle; $1.00 higher in Boston; $1.00 higher on 1x6-in. size in Chicago; and up about $17.00 in Pittsburgh. Long Leaf Yellow Pine is off $2.00 on 2-in. boards in Birmingham. Spruce is up $1.00 in Boston, as is Native Pine in Denver.

The Seattle base price for form grade fir plywood remains unchanged, but many mills are out of the market.

Cement is 6c. per bbl. higher in Denver. Ready-mixed concrete is up 25c. per cu. yd. in Minneapolis due to a heating charge. Reinforcing bars are 10c. per 100 lb. higher in San Francisco for the only change in the construction steel list. Roofing material prices increased in Baltimore. Red lead is up 25c. per 100 lb. in all 20 cities.

Los Angeles carpenters new rate is $1.12½ per hour, an increase of 2½c. This is the only change in either the skilled or common labor rates for December.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT Per bbl., carload lots, including 40c per bbl. for bags, cash discount not deducted			SAND AND GRAVEL Per ton, carload lots			CRUSHED STONE Per ton, carload lots		CRUSHED SLAG Per ton, carload lots, f.o.b. plant		CONCRETE Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags *a*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.66	$2.61	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1 75‡	6.75
Birmingham	2.50	2.25	2.05	1.75	1.75	1.50	1.00	1.00	.90	1.15	5.80
Boston	2.75*b*	2.50*b*	2.30	1.20‡	1.20‡	.90‡	1.20‡	1.20‡	....	....	6.75*m*
Chicago	2.60	2.35	2.20	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.00	1.75	....	1.45*i*	1.45*i*	1.30*i*	1.70*i*	1.70*i*	1.70*i*	1.70*i*	6.55*i*
Dallas	2.47	2.22	2.02	1.75*p*	2.00*p*	1.25*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.08	2.83	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.24	1.99	1.79	1.55	1.65	.95	1.55	1.65	1.30‡	1.40‡	6.75
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.25*n*
Los Angeles	2.25*b*	2.05*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	2.90	2.65	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.60*j*
Montreal	....	1.82*r*	1.67*r*	....	....	1.25‡	.85‡*c*	1.00‡*c*	....	....	6.45*l*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.25*de*	1.25*de*	.75*de*	1.65*de*	1.75*de*	....	....	6.50
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.40‡	1.40‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.50
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.90*h*	.90*h*	.75*g*	.75*g*	7.50
San Francisco	2.16	1.96	1.66	1.36	1.36	1.36	1.46	1.46	....	....	6.95
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery. 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

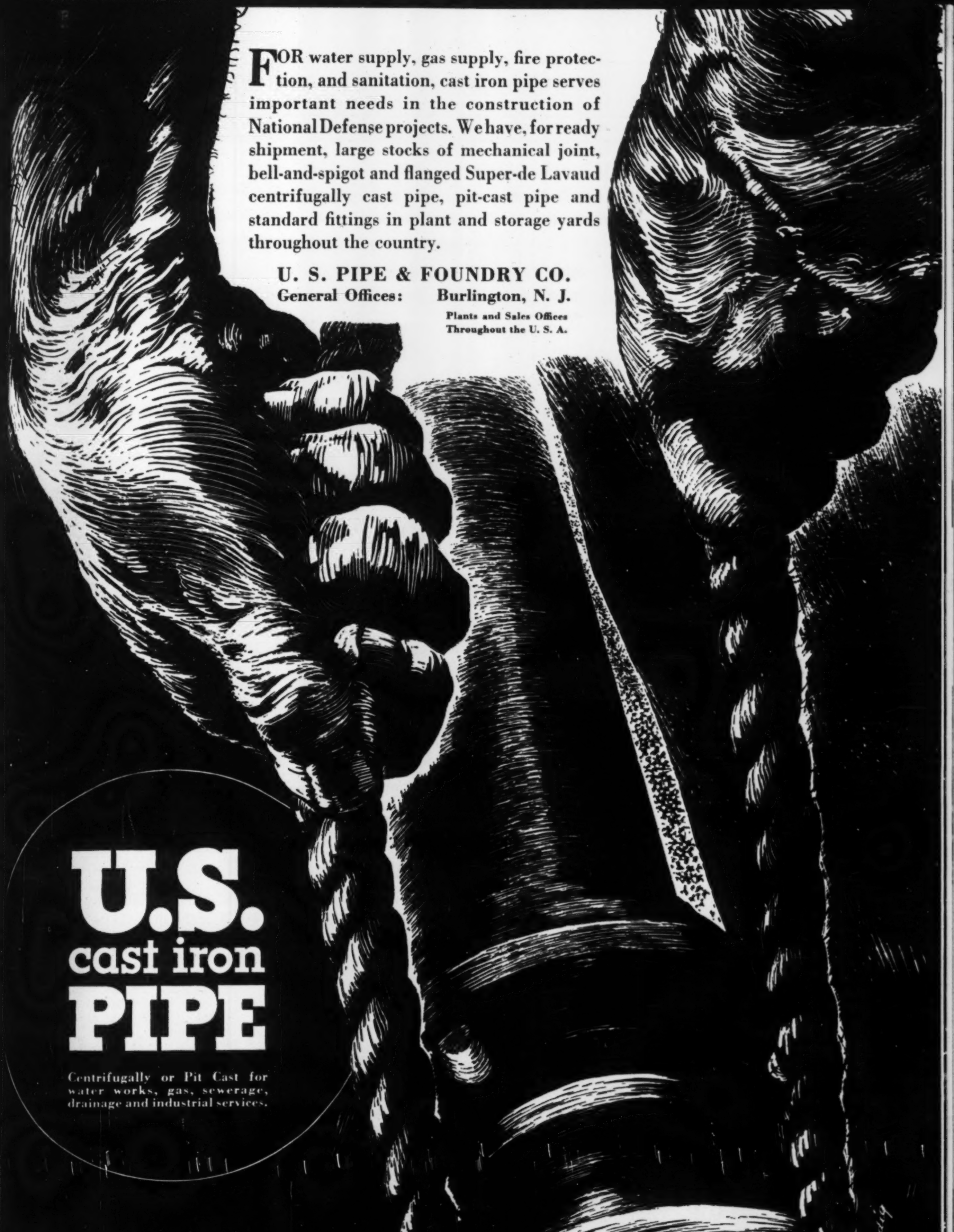
Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn.	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hannibal, Mo.	1.70	1.65	Norfolk, Va.	1.65	1.60	Universal, Pa.	1.65	1.60
Hudson, N. Y.	1.75	1.70	Northampton, Pa.	1.55	1.50	Waco, Tex (5c. tax in Tex.).	1.75	1.70
Independence, Kans.	1.70	1.65	North Birmingham, Ala.	1.70	1.65	Montreal	1.55	1.55

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT Per ton, less than 80 penetration		ASPHALT BINDERS—FLUXES Per gal., 80-300 penetration		CUTBACK ASPHALT Per ton		ROAD OILS Per gal.	ASPHALT EMULSION (Quick-breaking) Per gal.	
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3¾x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$17.30*e*	$23.83*e*	$0.0695*e*	$0.1018*e*	$0.0734*he*	$0.1257*h*	$0.0634*e*	$0.0734	$0.1257
Baltimore	150.00‡	45.00‡	2.75	14.00	20.00	.06	.09	.065*h*	.115*h*	......	......	......
Birmingham	......	27.50*j*‡	....	18.20	23.20	.0747	.1047	.0834*h*	.1484*h*	......	......	......
Boston	90.00	47.50	3.25	14.00	20.00	.06	.09	.065*h*	.115*h*	......	.09‡	.12‡
Chicago	140.00	50.00	1.80*d*	14.50	18.50	13.00*g*	17.00*g*	.06*h*	.09*h*	.04	.09	.125
Cincinnati	112.00	37.50	....	13.50	17.50	.07	......	16.80	......	.0525	......	.075
Cleveland	110.00	37.50	2.80	15.50	20.50	.065	.075	.075*h*	.085*h*	.0375	.08	.09
Dallas	......	30.00	....	13.25	20.30	.06	.103	15.00	24.80	.055	.05/.07	.07/.09
Denver	......	27.50	....	.....	.....	......	......	......	......	......	......	....
Detroit	......	35.00	....	13.15*f*	18.45*f*	.061	.0984	13.15	17.20	.0475	.061	.0923
Kansas City	......	40.00	....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	......	50.00	....	6.50*b*	15.00	6.50*bg*	15.00*bg*	5.50*b*	......	.0192	.0525	.1125
Minneapolis	......	......	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	......	......
Montreal	75.00	......	3.62	16.60	24.25	.116	.1485	.115*h*	.135*h*	.08	.135	.185
New Orleans	......	......	....	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	......	.078	......
New York	......	......	2.80	15.00	21.00	.06	.09	.065*h*	.115*h*	......	.07	.11
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	135.00	38.75	....	.....	.....	......	......	......	......	......	......	......
St. Louis	110.00/121.00	37.00	....	14.00	19.00	14.00*g*	19.00*g*	.06*h*	.095*h*	.04	.09	.125
San Francisco	......	70.00	....	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0525	.1125
Seattle	......	60.00*c*	....	14.70	24.10	......	24.10*g*	9.50/10.50	23.00/24.00	7.75*g*	.0575*i*	.1308*i*

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in.



FOR water supply, gas supply, fire protection, and sanitation, cast iron pipe serves important needs in the construction of National Defense projects. We have, for ready shipment, large stocks of mechanical joint, bell-and-spigot and flanged Super-de Lavaud centrifugally cast pipe, pit-cast pipe and standard fittings in plant and storage yards throughout the country.

U. S. PIPE & FOUNDRY CO.
General Offices: Burlington, N. J.
Plants and Sales Offices
Throughout the U. S. A.

U.S.
cast iron
PIPE

Centrifugally or Pit Cast for water works, gas, sewerage, drainage and industrial services.

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ½-in. billet *b*	RIVETS ¾-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std. Spikes *c*	Tie Plates *c*	Track bolts
Birmingham.....	$2.10	$2.15	$3.40	$2.55	.....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago.........	2.10	2.15	3.40	2.55	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh.......	2.10	2.15	3.40	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo..........	2.10	2.15	.....	.....	2.40	.....	.....	.....	.....	.....	2.15	.....
Cleveland........	2.10	2.15	3.40	2.55	.....	.....	.....	.....	.....	.....	.....	.....
Youngstown.....	.....	2.15	.....	.....	.....	.....	.....	.....	.....	3.00	.....	.....
Detroit..........	.....	2.25‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gulf ports.......	2.45*a*	2.40*a*	.....	.....	2.85*a*	.....	.....	.....	.....	.....	.....	.....
Pacific ports.....	2.75*a*	2.50*a*	.....	.....	2.95*a*	.....	.....	.....	.....	3.00	2.30	.....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates, alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb. base price	REINFORCING BARS* Per 100 lb., ½ in., base price 15 tons or over *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH Per 100 sq.yd. carload lots Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta..........	$2.34	$2.39	$2.14	.02½	.10	$21.00	$23.00	$1.82	$1.35	$0.1719	$3.04
Baltimore........	3.70	2.90	2.75	......	.10	24.00	26.00	1.70	1.27	.1611	2.90
Birmingham.....	2.10*a*	2.15	2.15	.02½	.10	20.50	22.50	1.80	1.34	.1701	....
Boston..........	3.85	2.61	2.46	$20 C.L.	.10	21.50	23.50	1.76	1.31	.1656	3.14
Chicago.........	2.10*a*	2.15	2.05	.03	.05	19.50	21.50	1.67	1.25	.1575	2.40
Cincinnati.......	3.68	2.46*c*	2.36*c*	......	.05	20.50	22.50	1.66	1.25	.1566	....
Cleveland........	3.58*g*	2.15	2.05	.02½	.10	22.50	23.50	1.66	1.25	.1566	....
Dallas...........	4.60	3.25	3.25	......	.....	22.50	24.50	1.93	1.42	.1827	....
Denver..........	4.35	3.95	3.80	......	.....	23.50	25.50	1.97	1.45	.1863	....
Detroit..........	3.60‡	2.25	2.15	......	.10	22.50	24.50	1.68	1.26	.1584	2.66
Kansas City.....	4.00	2.51*c*	2.36*c*	.0	.05	15.50	19.00	1.78	1.33	.1683	2.86
Los Angeles......	3.65*f*	2.25	2.10	.02½	.05	23.00	27.50	1.93	1.42	.1827	3.65
Minneapolis......	3.80‡	2.48*c*	2.33*c*	.0	.10	19.50/20.50	21.50/22.50	1.80	1.34	.1701	2.73*d*
Montreal........	......	......	......	......	.....	26.50	29.00	2.99	2.08	.319	....
New Orleans.....	4.40	2.52	2.52	.05	.10	21.50	23.50	1.82	1.35	.1719	2.875
New York.......	3.75	2.39	2.29	......	.10	14.50	16.50	1.76	1.32	.1665	2.74
Philadelphia.....	3.55	2.66	2.56	......	......	19.50	21.50	1.71	1.28	.1611	2.72
Pittsburgh.......	2.10*a*	2.15	2.05	.02½	.10	21.50	24.50	1.59	1.20	.1503	2.40
St. Louis........	3.47	2.39	2.29	.0	.05	24.00	28.00	1.69	1.27	.1602	2.70
San Francisco....	3.35	2.50	2.35	.02½	.10	19.00	25.50	1.93	1.42	.1827	3.25
Seattle..........	2.75*e*	2.50*e*	......	......	......	25.50	27.50	1.93	1.42	.1827	2.95*e*

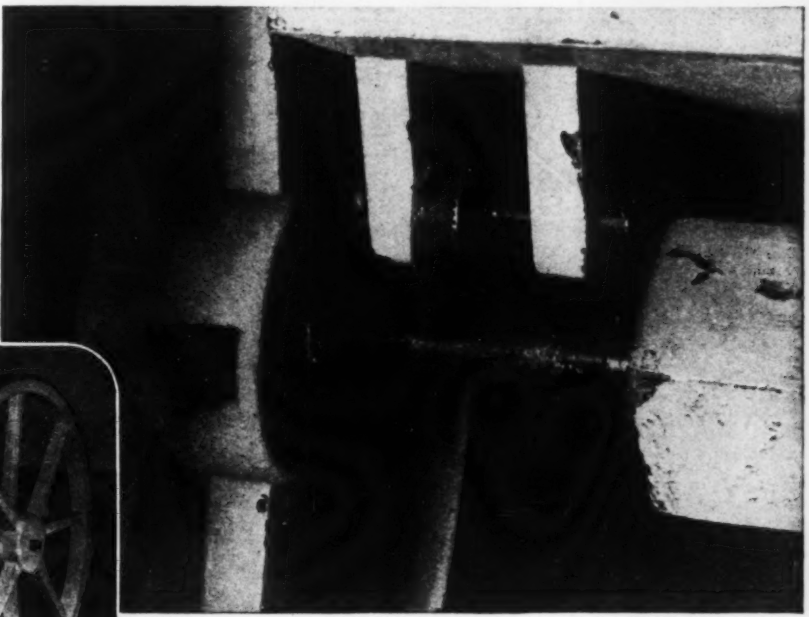
‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

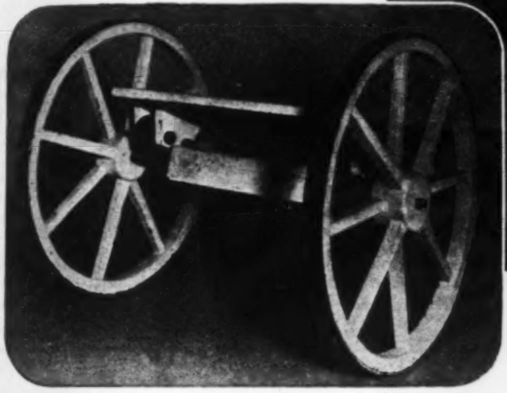
PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.*a*	VITRIFIED SEWER PIPE Per foot, std. 8 in., s.s.	delivered std. 12 in., s.s.	ASTM 24 in.,	C13–35 36 in.,	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONCRETE SEWER PIPE Per ft., delivered; ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h* 1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in.; Lap Weld Black %	Galv. %
Atlanta........	$49.40	$0.26*b*	$0.468*bc*	$1.8525	$1.68*c*	$85.00	$128.00	$0.45	$1.642	62.2	54.2	59.7	51.2
Baltimore......	52.80	.35	.60	2.30	6.80	115.00	150.00	.50	1.75	65.5	57.5	63.00	54.5
Birmingham...	45.00	.26	.468	1.7875	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston........	55.00	.231	.4455	1.89	5.2275	180.00‡	280.00‡	.50	2.30	64.1	56.1	61.6	53.1
Chicago.......	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati.....	52.70	.245	.4995	1.9335	5.6375	105.00	170.00	.60	1.70	65.9	57.9	63.4	54.9
Cleveland......	54.24	.196	.378	1.485	4.51	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas.........	58.20	.28	.504	2.016	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver........	60.60	.24†	.52†	2.16†	......	130.00	240.00	....	....	58.4	50.4	55.7	47.2
Detroit........	54.24	.245	.4725	1.935	4.408	66.45	105.00	.33	1.50	66.3	58.3	63.8	55.3
Kansas City...	55.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles....	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	59.6	51.6	57.0	48.6
Minneapolis....	57.20	.24†	.432†	1.728†	4.60†	......	......	.70	1.80	64.2	56.2	60.7	52.2
Montreal......	60.00	.55	.90	3.68	5.95*e*	135.00‡	260.00‡	.48	1.92	......	......	......	....
New Orleans...	51.38	.26	.48	1.69	......	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York.....	52.20	.32	.63	2.52	6.45	......	......	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia...	50.90	......	......	......	......	......	......	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh.....	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85*g*	2.00*g*	68.5*i*	60.5*i*	66.0*i*	57.5*i*
St. Louis......	52.48	.24	.432	1.728	3.96	85.00	170.00	.75*j*	1.80*k*	65.1	57.1	62.0	53.5
San Francisco..	55.00	.3275*c*	.5895*d*	2.358	5.895	107.25	178.75	.54	2.50	......	......	......	....
Seattle........	55.35	.35	.63	2.52	6.30	72.00	175.00	.35*f*	1.30*f*	......	......	......	....

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N.J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft: ½ in., 8½c.; ¾ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld—2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37.

THE TIMKEN Bearing HAD ITS BEGINNING 425 YEARS AGO!

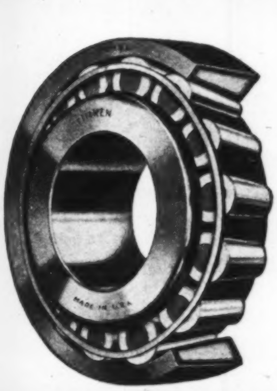




Model of roller bearing invented by Leonardo Da Vinci (1452-1519). Photographs courtesy New York Museum of Science & Industry.

There's a vast difference between the highly-developed, precise mechanism of the modern TIMKEN Bearing and Leonardo Da Vinci's crude device shown above. Although it is more than four centuries since Da Vinci conceived the first roller bearing however, his ideas are basic principles of the roller bearing of today. These principles are: (1) true rolling motion to eliminate friction; (2) line contact of bearing surfaces to assure maximum load capacity and constant alignment of moving parts. Thus the TIMKEN Roller Bearing may be said to have had its beginning in the fifteenth century.

Over 200 working models of inventions of the world-famous artist, scientist and engineer, Leonardo Da Vinci—including the roller bearing—are on display in the New York Museum of Science and Industry, RCA Building, Rockefeller Center. When you visit the Museum also be sure to see the exhibit of modern TIMKEN Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and industrial machinery of all kinds.



The TIMKEN Bearing of today

TIMKEN Bearings give you the advantages of *"line contact"* (greater capacity by distributing loads along the entire length of rollers); *tapered design* (ability to carry radial loads, up and down, thrust loads, from the side, and any combination of both); the greater precision and capacity resulting from *wide-area contact* between the ends of the rollers and the undercut rib of the cone; the one-piece multiple perforated cage; Timken-made Electric Furnace Alloy Steel, the most enduring material ever developed for tapered roller bearings; and the finest finish known to modern bearing science.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN

TAPERED ROLLER BEARINGS

LUMBER, TIMBER, PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) *All Fir planks No. 2 common· Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD* Rail freight increment (See note for base price)	
	1x6 S4S	1x8 S4S	2x4 S4S	2x6 S4S	2x8 S4S	2x10 S4S	3x12 Rgh	6x12 Rgh	12x12 Rgh	2x12 Rgh	12x12 Rgh	5/8"	3/4"
Atlanta	$32.00	$32.00	$27.00	$28.50	$28.50	$32.00	$34.50	......	......	$47.00	$57.00	$17.75	$21.60
Baltimore	37.00	38.50	38.00	39.00	39.00	40.00	52.00	......	......	74.00	76.00	17.35g	21.15g
	39.00	*39.00*	*41.00*	*40.00*	*40.00*	*39.00*	*52.00*	*$52.00*	*$52.00*	......	......	......	......
Birmingham	34.00	34.00	31.00	31.00	31.50	32.00	42.00	42.00	51.00	......	......	16.25	19.85
1	38.00	38.00	35.00	35.00	36.00	36.00	58.00	......	......	55.00	58.00	......	......
Boston	34.00[2]	34.00[2]	37.00[3]	37.00	57.00[1]	62.00[1]	80.00[1]	......	......	80.00	80.00	17.35g	21.15g
	33.00	*33.00*	*37.00*	*37.00*	*40.00*	*40.00*	*49.00*	*49.00*	*49.00*	......	......	......	......
Chicago	42.00	42.00	38.00	38.00	37.00	42.50	52.00	......	......	90.00	100.00	13.80	16.80
	40.00	*40.00*	*40.00*	*40.00*	*40.00*	*42.00*	*45.00*	*45.00*	*45.00*	......	......	......	......
Cincinnati	37.50	39.00	35.00	35.00	36.00	41.00	50.00	......	......	60.00	63.00	16.25	19.85
	......	......	......	......	......	......	*52.00*	*52.00*	*52.00*	......	......	......	......
Cleveland	38.50	40.00	40.00	38.00	36.00	42.00	49.00	49.00	49.50	82.50	82.50	16.70	20.40
Dallas e	38.00	39.00	38.00	36.00	37.00	38.50	52.50	52.50	52.50	76.00	81.00	13.90	16.95
Denver ‡	46.00[4]	44.00[4]	48.00[4]	47.00[4]	47.00[4]	49.00[4]	48.00[4]	58.00[4]	65.00[4]	......	......	9.90	12.05
Detroit	42.00	42.00	40.00	42.00	42.00	44.00	51.00	......	......	50.00	59.00	16.25	19.85
	......	......	......	......	......	*49.00*	*52.00*	*59.00*	*59.00*	......	......	......	......
Kansas City	40.00	41.00	37.50	37.50	37.00	37.50	40.00	......	......	65.00	70.00	12.25	14.95
	37.50	*37.50*	*38.50*	*38.00*	*38.00*	*37.50*	*40.00*	*43.00*	*43.00*	......	......	......	......
Los Angeles a	*40.00*	*40.00*	*39.00*	*39.00*	*36.00*	*36.00*	*43.00*	*48.00*	*43.00*	......	......	9.35gh	11.35gh
Minneapolis ‡b	40.00[6]	40.00[6]	......	......	......	......	......	......	......	......	......	12.05	14.70
‡	*42.00*	*42.00*	*42.00*	*40.00*	*40.00*	*42.00*	*44.50*	*53.50*	*53.50*	......	......	......	......
Montreal †[7]	*34.00*	*36.00*	*32.00*	*34.00*	*36.00*	42.00	45.00	......	......	155.00	165.00	......	......
	52.00	*54.00*	*52.75*	*55.75*	*57.75*	*60.75*	*52.00*	*52.00*	*52.00*	......	......	......	......
New Orleans	24.00	25.00	25.00	24.00	24.00	25.00	46.00	......	......	62.00	69.00	13.90	16.95
	29.00	*29.00*	*32.00*	*33.00*	*35.00*	*34.00*	*36.00*	......	......	......	......	......	......
New York ‡	48.00	49.00	43.00	45.00	45.00	46.00	48.00	......	......	82.50f	85.00f	17.35g	21.15g
‡	......	......	*50.00*	*50.00*	*50.00*	*50.00*	*50.00*	*52.50*	*52.50*	......	......	......	......
Philadelphia	24.00	24.50	25.50	25.50	27.50	27.50	29.00	......	......	50.00	57.50	17.35g	.1512g
	35.00	*36.50*	*39.00*	*38.25*	*29.00*	*39.00*	*44.00*	*32.00*	*32.00*	......	......	......	......
Pittsburgh	50.80	53.20	62.75	55.00	60.85	62.50	76.25	......	......	......	......	17.00	20.70
	69.20	*68.10*	*66.10*	*65.30*	*65.20*	*65.65*	*88.75*	*88.75*	*88.75*	......	......	......	......
St. Louis ‡c	42.00	42.00	38.00	37.00	38.00	39.00	50.00	*58.00*	*58.00*	76.00	75.00	13.90	16.95
San Francisco d	*28.00*	*27.00*	*28.00*	*29.50*	*29.00*	*29.50*	*29.50*	*28.00*	*28.00*	......	......	7.30g	8.90g
Seattle	*25.00*	*25.00*	*25.00*	*25.00*	*25.00*	*25.00*	*32.00*	*32.00*	*32.00*	......	......	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [6] Western Pine, No. 3 Common. [7] Spruce. [8]Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft. † Montreal prices stabilized for balance of year by order of Dominion Controller of Lumber.

NOTE: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 5/8", $81.60; on 3/4", $89.90; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *Many mills out of market due to rush of defense orders. *g* Lower rate by water shipment. *h* 50,000 lb. minimum

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	75%	75%	$0.15
Baltimore	82%	81%	.15
Birmingham	75%	75%	.105
Boston	82%	82%	.15
Chicago	79%	79%	.15
Cincinnati	77%	77%	.15
Cleveland	79–10–10%	79–10–10%	.205
Dallas	78%	78%	.165
Denver	77%	77%	.15e
Detroit	79–10%	79–10%	.15
Kansas City	77–10%	77–10%	.165
Los Angeles	86%d	88%d	.1575
Minneapolis	76%	76%	.16
Montreal	......	......	.17†
New Orleans	70%	75%	.16
New York	81%	82%	.22f
Philadelphia	82–10%d	83–10%d	.15
Pittsburgh	79%	79%	.1425
St. Louis	77–10%	77–10%	.155
San Francisco	78%d	83%d	.155
Seattle	85%d	88%d	.1575

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla	$0.105	$0.14	$0.16
W. of Miss. to Rocky Mtn. States, and Fla	.11 –.12	.135 –.15	.155 –.17
Rocky Mtn. States	.11 –.1325	.13 –.145**	.15 –.165**
Pacific N. W. States	.1075–.115	.1375–.15	.1575–.17
Pacific S. W. States	.1050–.1175	.135 –.1475	.155 –.1625

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6"x8"x8' Untr.	6"x8"x8' Tr.	7"x9"x8'6" Untr.	7"x9"x8'6" Tr.
Boston	Oak	$1.20	....	$1.65	....
	Pine	1.50	$2.25a	2.25	$3.20a
New York	S. L. Sap Pine	1.20/1.30	1.95	1.60	2.45
	Mixed Oak	1.55	2.05	2.00	2.55
Birmingham	White Oak	.85	1.50a	1.35	1.70a
	Southern Pine	.55b	1.10ab	.70	1.30a
Chicago	Oak	....	1.65a	....	2.25a
	Southern Pine	....	1.53a	....	2.13a
Los Angeles	Douglas Fir	.64	1.38a	.90	1.80a
Philadelphia	Red Oak	1.10	....	....	2.40a
St. Louis	White Oak	1.12	....	1.50	....
	Red Oak	1.12	1.60a	1.50	2.05a
	Sap Pine or Cypress	1.02	....	1.40	....
San Francisco	Douglas Fir	1.00bef	....	....	2.45caf
Montreal	Birch or Maple	.65	1.05a	.75	1.35a

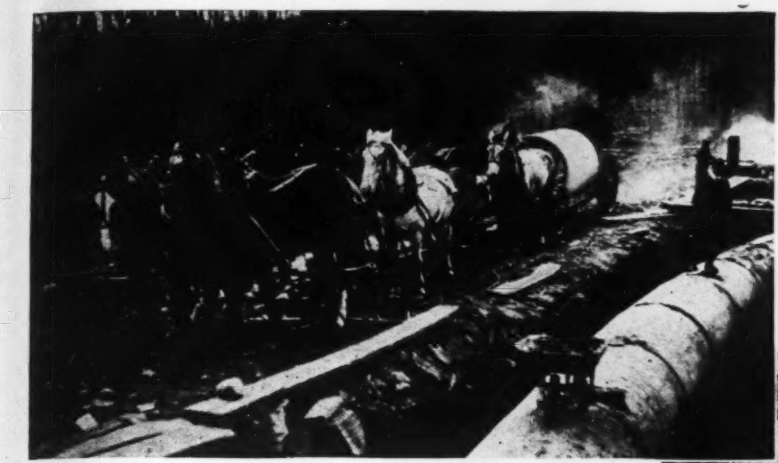
Tr.—Treated; Untr.—Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.00–2.85
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	20.50–35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb	4.75

HARTFORD, CONN., NOW BUILDS ITS FIFTH LOCK JOINT PIPE LINE



1918 (left)

Back in 1918, six-horse teams were used to deliver the 48" pipe for Hartford's first Lock Joint Pressure Pipe Line.

1929 (below)

In 1929, 11 years later, Hartford's third Lock Joint Pressure Pipe Line (36" and 42") is installed.

A new and more abundant supply of water is now being developed to meet Hartford's steadily increasing requirements. Today this city has one of the most modern and efficient water systems in the Country.

Lock Joint Pipe has had an important part in the development of this water supply system. Twenty-two years ago, in 1918, Hartford installed its first Lock Joint Pipe Line—some 4800 feet of 48" diameter pipe. As a result of the excellent performance of this line, and subsequent installations, Lock Joint Pipe Lines were added to the system in 1927, 1929, 1938 and again in 1940.

This fifth Lock Joint Reinforced Concrete Pipe Line installation, known as the Barkhamsted-Nepaug and Collinsville By-Pass Pipe Lines, is 48" in diameter. After its completion, there will be a total of some 98,000 feet of 30" to 48" diameter Lock Joint Pipe Lines in the Hartford water supply system.

In addition to Hartford, many other important cities including Portland, Me., Norfolk, Va., Denver, Colo. and Washington, D. C. have installed several Lock Joint Pipe Lines, over a period of years.

These repeat orders are all the result of the satisfactory performance of Lock Joint Reinforced Concrete Pressure Pipe which possesses all of the essential requirements for permanently economical pipe lines.

1940 (above)

Installing 48" diameter pipe for the Barkhamsted-Nepaug and Collinsville By-Pass Pipe Lines.

LOCK JOINT *Reinforced Concrete* **PRESSURE PIPE**

LOCK JOINT PIPE CO. Established 1905 AMPERE, N. J.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over, 8x12x12 in.	10x12x12 in.	12x12x12 in.	BRICK Per M. in quantity. Common backing	Straight hard	LIME Per ton, Hydrated finishing	In paper, Common hydrated	Carload lot, Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$16.00	$26.50	$17.00	$17.00
Baltimore	75.00	80.00	150.00	180.00	225.00	280.00	14.00k	17.00k	18.50	15.00	2.50m
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	13.50	16.50	18.11	12.64	1.66o
Boston	95.05a	101.40a	190.05a	215.35	279.20a	319.10a	17.00i	20.00i	21.00	14.00	18.00l
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	......
Cleveland	56.50	60.00	112.50	135.00	182.50	209.00	16.00	16.00	15.00j	12.00j	2.75jm
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50i	13.50i	19.00	15.00	.95n
Denver	84.80	94.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00j	17.00j	35.00j
Detroit	69.00	73.60	138.00	176.00	232.00	265.00e	16.00	17.00	16.00	13.75	14.75
Kansas City	64.50	66.50	86.00c	125.50	159.75	186.25	14.25	24.00	19.10	12.80	10.70
Los Angeles	73.50†r	89.50†r	128.00c†r	210.00†r	368.00†r	460.00†r	13.50	15.00	16.50	......	17.50
Minneapolis	71.45	76.20	143.95	171.45	173.80	242.10	13.10	15.10g	21.00	16.00	19.00
Montreal	72.20a	77.50a	142.50a	76.00at	165.80a	248.70	20.75	28.00	23.50	17.00	12.00
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	......	18.30	12.08	14.10
New York	87.00	93.00	128.00c	193.30h	238.80h	295.60h	13.00	......	19.00	14.00	1700
Philadelphia	80.50	85.90	161.10	193.30	238.80	295.60	15.50s	18.00s	15.50l	9.55q	12.05q
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.90	15.40	2.55m
St. Louis	62.00	88.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30lm
San Francisco	84.00	94.50	225.00	......	......	......	14.00	17.00	.55o	.40o	2.05m
Seattle	100.00	110.00	220.00	......	......	......	17.50f	17.50f	20.00s	20.00s	20.00s

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6x12x12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c. per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5⅓ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

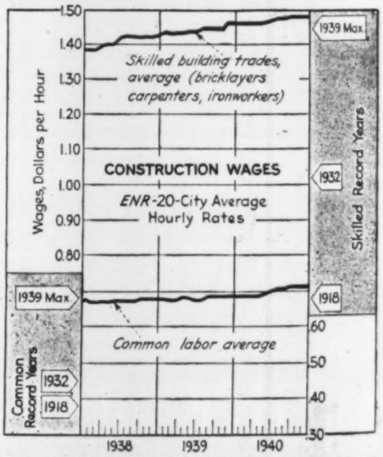
	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. Dry *a*	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite *b*	Aluminum *c*	Ferric Oxide *d*	ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85-90 lb. per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$9.50	$13.125	$1.30	$2.25	$1.20	$1.90	$1.61	$1.61	$0.27	$29.00
Baltimore	9.25	12.75	1.75	2.50	2.00	2.40	2.95	2.95	.55	29.00
Birmingham	9.50	13.125	2.35	2.75	1.85	1.98	1.57	1.57	.32	27.00
Boston	9.25	12.75	1.85‡	2.50‡	1.80‡	1.80‡	1.85h‡	1.85h‡	.50‡	20.00‡
Chicago	9.25	12.75	1.96	2.63	1.68	1.45hf	1.50hf	1.50hf	.26f	22.00f
Cincinnati	9.25	12.75	1.65	2.85	1.55	2.40	2.39h	2.39h	.36	21.00
Cleveland	9.25	12.75	1.90	2.60	1.60	1.75	1.50h	1.50h	.35	21.00
Dallas	9.25	13.50	1.88	2.11	....	2.75h	2.60h	2.70h	.275	31.00
Denver	9.75	13.25	1.65	2.40	.17l	2.45	4.00	3.00	.35	18.00
Detroit	9.25	12.75	1.75	2.75	1.25	2.40	2.50	2.50	.35	26.00
Kansas City	9.25	12.875	2.15g	2.40g	1.67g	1.93	2.09	2.09	.25	25.00
Los Angeles	9.50	13.25	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	9.25	12.875	....	....	....	1.75i	1.50hi	1.50hi	.29	21.00
Montreal	9.25	9.00	2.25	2.80	2.35	2.53	1.68	1.78	.70	1.68k
New York	9.25	12.75	1.88	2.55	1.60	1.75	1.50h	1.50h	.23	24.00
Philadelphia	9.25	12.75	....	....	....	1.92e	1.99he	1.99he	.41e	21.00
Pittsburgh	9.25	12.75	1.05	1.95	.80	1.95	1.94h	1.94h	.34	26.00
St. Louis	9.25	12.75	1.90/2.00	2.60/2.80	1.60/2.00	2.04	1.50	1.50	.24	21.00
San Francisco	9.50	13.00	1.80	2.75	1.10/2.00	1.65	2.26	2.26	.28	17.00
Seattle	9.50	13.25	1.80	2.60	....	1.81	1.30/2.00	1.75	.35	28.00j

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* Per 100 lb. *l* Per lb.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.375	.625	.625
Birmingham	1.50	1.125	1.375	1.125	1.00	.40	.40
Boston	1.50	1.375	1.625	1.375/1.625	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.625	1.45	1.55	1.375/1.525	1.625	.75	.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65b	1.43b	1.43b	1.43b	1.50b	.718b	.718b
Detroit	1.50	1.25	1.625	1.50	1.55	.60/.75	.60/.775
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.25	1.125	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25d	1.50	1.40	1.50e	.85	.85
New Orleans	1.50	1.25	1.375	1.375	1.40	.40	.50
New York	2.00b	1.85b	2.00	2.00b	2.00c	1.031	.875/.95
Philadelphia	1.65b	1.40	1.65	1.50	1.75	.70	.70
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.50	1.75	1.50/2.00	1.75	.45/.875	.875
San Francisco	1.75c	1.25	1.60	1.50	1.60c	.813	.813
Seattle	1.60	1.25	1.50	1.50	1.60	.90	.90
Montreal	.80	.70	.75	.65	.80	.45	.40

b 7 hr. day. *c* 6 hr. day *d* 35 hr. wk. *e* 30 hr. wk.



ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.481
ENR Common Average: $0.711